No. 200300221

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Oklahoma Agricultural Experiment Station

Whereas, THERE HAS BEEN PRESENTED TO THE

Secretary of Agriculture

AN APPLICATION REQUESTING A CERTIFICATE OF PROTECTION FOR AN ALLEGED DISTINCT VARIETY OF SEXUALLY REPRODUCED, OR TUBER PROPAGATED PLANT, THE NAME AND DESCRIPTION OF WHICH ARE CONTAINED IN THE APPLICATION AND EXHIBITS, A COPY OF WHICH IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PLANT VARIETY PROTECTION OFFICE, IN THE APPLICANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID APPLICANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A CERTIFICATE OF PLANT VARIETY PROTECTION UNDER THE LAW.

NOW, THEREFORE, THIS CERTIFICATE OF PLANT VARIETY PROTECTION IS TO GRANT UNTO THE SAID APPLICANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID APPLICANT(S) FOR THE TERM OF TWENTY YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF THE REQUIRED FEES AND PERIODIC REPLENISHMENT OF VIABLE BASIC SEED OF THE VARIETY IN A PUBLIC REPOSITORY AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM SELLING THE VARIETY, OR OFFERING IT FOR SALE, OR REPRODUCING IT, OR [illegible]PORTING IT, OR EXPORTING IT, OR CONDITIONING IT FOR PROPAGATION, OR STOCKING IT FOR ANY OF THE [illegible]VE PURPOSE , OR CONDITIONING IT FOR PROPAGATION, OR STOCKING IT FOR ANY OF THE ABOVE [illegible]OSE, OR USING IT IN PRODUCING A HYBRID OR DIFFERENT VARIETY THEREFROM, TO THE EXTENT [illegible]ED BY THE PLANT VARIETY PROTECTION ACT. IN THE UNITED STATES SEED OF THIS VARIETY [illegible]BE SOLD BY VARIETY NAME ONLY AS A CLASS OF CERTIFIED SEED AND (2) SHALL CONFORM TO THE NU[illegible] GENERATIONS SPECIFIED BY THE OWNER OF THE RIGHTS. (84 STAT. 1542, AS AMENDED, 7 U.S.C. 2321 ET SEQ.)

BERMUDAGRASS

'Riviera'

In Testimony Whereof, I have hereunto set my hand and caused the seal of the Plant Variety Protection Office to be affixed at the City of Washington, D.C. this twenty-seventh day of April, in the year two thousand and five.

Attest:

Commissioner
Plant Variety Protection Office
Agricultural Marketing Service

Secretary of Agriculture

REPRODUCE LOCALLY. *Include form number and date on all reproductions*

Form Approved - OMB No. 0581-0055

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
SCIENCE AND TECHNOLOGY - PLANT VARIETY PROTECTION OFFICE

APPLICATION FOR PLANT VARIETY PROTECTION CERTIFICATE
(Instructions and information collection burden statement on reverse)

The following statements are made in accordance with the Privacy Act of 1974 (5 U.S.C. 552a) and the Paperwork Reduction Act (PRA) of 1995.

Application is required in order to determine if a plant variety protection certificate is to be issued (7 U.S.C. 2421). Information is held confidential until certificate is issued (7 U.S.C. 2426).

1. NAME OF OWNER
Oklahoma Agricultural Experiment Station

2. TEMPORARY DESIGNATION OR EXPERIMENTAL NAME
OKS 95-1

3. VARIETY NAME
Riviera

4. ADDRESS *(Street and No., or R.F.D. No., City, State, and ZIP Code, and Country)*
Oklahoma State University
139 Agricultural Hall
Stillwater, OK 74078-6019

5. TELEPHONE *(include area code)*
405-744-5398

6. FAX *(include area code)*
405-744-5339

FOR OFFICIAL USE ONLY

PVPO NUMBER
20030021

FILING DATE
April 14, 2003

7. IF THE OWNER NAMED IS NOT A "PERSON", GIVE FORM OF ORGANIZATION *(corporation, partnership, association, etc.)*
Public Research Agency

8. IF INCORPORATED, GIVE STATE OF INCORPORATION

9. DATE OF INCORPORATION

10. NAME AND ADDRESS OF OWNER REPRESENTATIVE(S) TO SERVE IN THIS APPLICATION. *(First person listed will receive all papers)*
Dr. R. L. Westerman, Assistant Director
Oklahoma Agricultural Experiment Station
Oklahoma State University
139 Agricultural Hall
Stillwater, OK 74078-6019

FEES RECEIVED

FILING AND EXAMINATION FEES:
$ 3,652 —
DATE April 14, 2003

CERTIFICATION FEE:
$ 432 —
DATE April 14, 2003

11. TELEPHONE *(Include area code)*
405-744-5398

12. FAX *(Include area code)*
405-744-5339

13. E-MAIL
rwester@okstate.edu

14. CROP KIND *(Common Name)*
Bermudagrass

15. GENUS AND SPECIES NAME OF CROP
Cynodon dactylon var. dactylon

16. FAMILY NAME *(Botanical)*
Poaceae (Gramineae)

17. IS THE VARIETY A FIRST GENERATION HYBRID?
☐ YES ☒ NO

18. CHECK APPROPRIATE BOX FOR EACH ATTACHMENT SUBMITTED (Follow instructions on reverse)
- a. ☒ Exhibit A. Origin and Breeding History of the Variety
- b. ☒ Exhibit B. Statement of Distinctness
- c. ☒ Exhibit C. Objective Description of Variety
- d. ☒ Exhibit D. Additional Description of the Variety *(Optional)*
- e. ☒ Exhibit E. Statement of the Basis of the Owner's Ownership
- f. ☒ Voucher Sample *(2,500 viable untreated seeds or, for tuber propagated varieties, verification that tissue culture will be deposited and maintained in an approved public repository)*
- g. ☒ Filing and Examination Fee ($3,652), made payable to "Treasurer of the United States" *(Mail to the Plant Variety Protection Office)*

19. DOES THE OWNER SPECIFY THAT SEED OF THIS VARIETY BE SOLD AS A CLASS OF CERTIFIED SEED? *See Section 83(a) of the Plant Variety Protection Act)*
☒ YES *(If "yes", answer items 20 and 21 below)* ☐ NO *(If "no", go to item 22)*

20. DOES THE OWNER SPECIFY THAT SEED OF THIS VARIETY BE LIMITED AS TO NUMBER OF CLASSES? ☒ YES ☐ NO
IF YES, WHICH CLASSES? ☒ FOUNDATION ☒ REGISTERED ☒ CERTIFIED

21. DOES THE OWNER SPECIFY THAT SEED OF THIS VARIETY BE LIMITED AS TO NUMBER OF GENERATIONS? ☒ YES ☐ NO
IF YES, SPECIFY THE NUMBER 1,2,3, etc. FOR EACH CLASS.
1 FOUNDATION 1 REGISTERED 1 CERTIFIED
(If additional explanation is necessary, please use the space indicated on the reverse.)

22. HAS THE VARIETY (INCLUDING ANY HARVESTED MATERIAL) OR A HYBRID PRODUCED FROM THIS VARIETY BEEN SOLD, DISPOSED OF, TRANSFERRED, OR USED IN THE U. S. OR OTHER COUNTRIES?
☒ YES ☐ NO
IF YES, YOU MUST PROVIDE THE DATE OF FIRST SALE, DISPOSITION, TRANSFER, OR USE FOR EACH COUNTRY AND THE CIRCUMSTANCES. *(Please use space indicated on reverse.)*

23. IS THE VARIETY OR ANY COMPONENT OF THE VARIETY PROTECTED BY INTELLECTUAL PROPERTY RIGHT *(PLANT BREEDER'S RIGHT OR PATENT)*?
☐ YES ☒ NO
IF YES, PLEASE GIVE COUNTRY, DATE OF FILING OR ISSUANCE AND ASSIGNED REFERENCE NUMBER. *(Please use space indicated on reverse.)*

24. The owners declare that a viable sample of basic seed of the variety has been furnished with application and will be replenished upon request in accordance with such regulations as may be applicable, or for a tuber propagated variety a tissue culture will be deposited in a public repository and maintained for the duration of the certificate.

The undersigned owner(s) is(are) the owner of this sexually reproduced or tuber propagated plant variety, and believe(s) that the variety is new, distinct, uniform, and stable as required in Section 42, and is entitled to protection under the provisions of Section 42 of the Plant Variety Protection Act.

Owner(s) is(are) informed that false representation herein can jeopardize protection and result in penalties.

SIGNATURE OF OWNER	SIGNATURE OF OWNER
Robert L Westerman	
NAME *(Please print or type)*	NAME *(Please print or type)*
Robert L. Westerman	
CAPACITY OR TITLE / DATE	CAPACITY OR TITLE / DATE
Asst. Director, OAES / April, 7, 2003	

ST-470 (02-10-2003) designed by the Plant Variety Protection Office using Word 2000. Replaces former versions of ST-470, which are obsolete.

(See reverse for instructions and information collection burden statement)

20030021

GENERAL: To be effectively filed with the Plant Variety Protection Office (PVPO), **ALL** of the following items must be received in the PVPO: (1) Completed application form signed by the owner; (2) completed exhibits A, B, C, E; (3) for a seed reproduced variety at least 2,500 viable untreated seeds, for a hybrid variety at least 2,500 untreated seeds of each line necessary to **reproduce** the variety, or for tuber reproduced varieties verification that a viable *(in the sense that will reproduce an entire plant)* tissue culture will be deposited and maintained in an approved public repository; (4) check drawn on a U.S. bank for $3,652 ($432 filing fee and $3,220 examination fee), payable to "Treasurer of the United States" *(See Section 97.6 of the Regulations and Rules of Practice.)* Partial application will be held in the PVPO for not more than 90 days, then returned to the applicant as unfiled. Mail application and other requirements to Plant Variety Protection Office, AMS, USDA, Room 401, NAL Building, 10301 Baltimore Avenue, Beltsville, MD 20705-2351. Retain one copy for your files. All items on the face of the application are self explanatory unless noted below. Corrections on the application form and exhibits must be initialed and dated. **DO NOT** use masking materials to make corrections. If a certificate is allowed, you will be requested to send a check payable to "Treasurer of the United States" in the amount of $432 for issuance of the certificate. Certificates will be issued to owner, not licensee or agent.

Plant Variety Protection Office
Telephone: (301) 504-5518
FAX: (301) 504-5291
Homepage: http://www.ams.usda.gov/science/pvpo/pvp.htm

ITEM

18a. Give:
(1) the genealogy, including public and commercial varieties, lines, or clones used, and the breeding method;
(2) the details of subsequent stages of selection and multiplication;
(3) evidence of uniformity and stability; and
(4) the type and frequency of variants during reproduction and multiplication and state how these variants may be identified

18b. Give a summary of the variety's distinctness. Clearly state how this application variety may be distinguished from all other varieties in the same crop. If the new variety is most similar to one variety or a group of related varieties:

(1) identify these varieties and state all differences objectively;
(2) attach statistical data for characters expressed numerically and demonstrate that these are clear differences; and
(3) submit, if helpful, seed and plant specimens or photographs (prints) of seed and plant comparisons which clearly indicate distinctness.

18c. Exhibit C forms are available from the PVPO Office for most crops; specify crop kind. Fill in Exhibit C (Objective Description of Variety) form as completely as possible to describe your variety.

18d. Optional additional characteristics and/or photographs. Describe any additional characteristics that cannot be accurately conveyed in Exhibit C. Use comparative varieties as is necessary to reveal more accurately the characteristics that are difficult to describe, such as plant habit, plant color, disease resistance, *etc.*

18e. Section 52(5) of the Act requires applicants to furnish a statement of the basis of the applicant's ownership. An Exhibit E form is available from the PVPO.

19. If "Yes" is specified *(seed of this variety be sold by variety name only, as a class of certified seed)*, the applicant **MAY NOT** reverse this affirmative decision after the variety has been sold and so labeled, the decision published, or the certificate issued. However, if "No" has been specified, the applicant may change the choice. *(See Regulations and Rules of Practice, Section 97.103).*

22. *See Sections 41, 42, and 43 of the Act and Section 97.5 of the regulations for eligibility requirements.*

23. *See Section 55 of the Act for instructions on claiming the benefit of an earlier filing date.*

21. CONTINUED FROM FRONT *(Please provide a statement as to the limitation and sequence of generations that may be certified.)*

Syn-1 generation seed from fields planted with vegetative propagules (sprigs) of the three parent plants may be classified as Foundation, Registered or Certified. Foundation and Registered seed classes are for the specific purpose of establishing Certified class sod production fields by contractual agreement between the owner and licensee(s). Certified class seed will be the seed of regular commerce.

22. CONTINUED FROM FRONT *(Please provide the date of first sale, disposition, transfer, or use for each country and the circumstances, if the variety (including any harvested material) or a hybrid produced from this variety has been sold, disposed of, transferred, or used in the U.S. or other countries.)*

First sale of seed was April ~~15~~ 26, 2002 by Johnston's Seed Co. Enid, OK. Sale of Riviera seed in 2002 was limited to a few hundred pounds.

RMD 10/18/2004

23. CONTINUED FROM FRONT *(Please give the country, date of filing or issuance, and assigned reference number, if the variety or any component of the variety is protected by intellectual property right (Plant Breeder's Right or Patent).)*

NOTES: It is the responsibility of the applicant/owner to keep the PVPO informed of any changes of address or change of ownership or assignment or owner's representative during the life of the application/certificate. There is no charge for filing a change of address. The fee for filing a change of ownership or assignme or any modification of owner's name is specified in Section 97.175 of the regulations. *(See Section 101 of the Act, and Sections 97.130, 97.131, 97.175(h) of the Regulations and Rules of Practice.)*

To avoid conflict with other variety names in use, the applicant must check the appropriate recognized authority. For example, for agricultural and vegetable crops, contact: Seed Branch, AMS, USDA, Room 213, Building 306, Beltsville Agricultural Research Center--East, Beltsville, MD 20705. Telephone: (301) 504-8089. http://www.ams.usda.gov/lsg/seed.htm

ST-470 (02-10-2003) designed by the Plant Variety Protection Office with Word 2000. Replaces former versions of ST-470, which are obsolete.

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18a. Exhibit A. Origin and Breeding History of the Variety.

'Riviera' (experimental designation 'OKS 95-1'), *Cynodon dactylon* var. *dactylon*, is a tetraploid (2n=4x=36 chromosome) synthetic variety produced by the polycrossing of three clonal parent plants. The three parents were selected in spring 1995 from a breeding population grown as individual space-planted plants for purposes of cyclic selection. The parent plants were selected on the bases of visual and/or measured assessments of characters conditioning turf quality, transition zone adaptation, and seed production. The three clonal parent plants were planted in a field polycross nursery on the Agronomy Research Station, Stillwater, Oklahoma in July 1995. Evaluations of Riviera have been from plantings established using Syn-1 seed produced from this block.

The breeding population from which the three Riviera parent plants were selected was developed in 1994 using the following bermudagrasses.

Accession (A) Number or other ID	**Origin**
A12388	Seed collected from site near Zhaoqing City, Guangdong Province, Peoples Republic of China, 8/22/93
A12390	Seed collected from Ziaoshiao Grass Res. Stn., Yunnan Province, PRC, 8/27/93
A12392	Seed collected from site in Xindian County, Yunnan Province, PRC, 8/28/93
A12396	Seed collected from site near Kunming, Yunnan Province, PRC, 8/30/93
A12398	Seed collected from site near Kunming, Yunnan Province, PRC, 8/30/93
A12399	Seed collected from site near Kunming, Yunnan Province, PRC, 8/30/93
A12402	Seed collected from site near Kunming, Yunnan Province, PRC, 8/30/93
A12403	Seed collected from site near Kunming, Yunnan Province, PRC, 8/30/93
A12407	Seed collected from site near Emeishan City, Sichuan Province, PRC, 9/3/93
A12410	Seed collected near Nanjing, Jiangsu Province, PRC, 9/6/93
CdaRS C2	Recurrent selection cycle 2 of an Oklahoma State University breeding population first formulated in 1982.

The population was formed by growing 20 plants of each of the above indicated bermudagrasses in an isolated field polycross nursery planted on the Oklahoma State University Agronomy Research Station at Stillwater, OK in early spring 1994. Plants of each bermudagrass accession were arranged in the polycross to facilitate random

crossing. A portion of the seed harvested from the field polycross nursery in early July 1994 was germinated soon after harvest and 1024 resultant plants were transplanted from the greenhouse to a field selection nursery in mid-August 1994. It was from this nursery that the three Riviera parent plants were selected in late June 1995. No other commercial variety has been developed to date from the breeding population from which Riviera was derived.

Riviera is uniform and stable within defined limits of natural variation existing within the Syn-1 generation. Only the Syn-1 generation seed generation is allowed. Syn-1 generation seed is produced from plantings of approximately equal quantities of Foundation class clonal propagules (sprigs) of the three parent plants. The Syn-1 generation seed may be classified as Registered class, or downgraded to the Certified class. Registered class seed can be used only for the specific purpose of establishing plantings from which Certified class sod is to be harvested and marketed. Certified seed is the seed of regular commerce. The three clonal parent plants are non-inbred and therefore genetically heterozygous. Strong self-incompatibility ($\leq$ 2% seed set from self-pollination) of the parent plants ensures seed of predominantly hybrid origin. Random mating (polycrossing) among the three parent plants produces offspring that are phenotypically heterogeneous, but whose mean value for a given trait is stable and predictable. The Syn-1 generation plants that are most distinctly different in appearance from the norm due to color, size, or texture are found within the tails of the statistically normally distributed population. Accordingly, these variant plants constitute less than 5% of the plants in the population. The extent (range) of variation found among plants for the important descriptors is addressed in Exhibit B. No off-type plants resulting from crossing with other varieties, or from mechanical contamination with other varieties, have been detected.

18b. Exhibit B. Statement of Distinctness.

'Riviera' is most similar to 'Jackpot' and 'Mirage' in adaptation and morphological characteristics. Comparisons of Riviera with Jackpot and Mirage for descriptive characteristics are summarized in Tables B1 through B18. Four conspicuous morphological differences between Riviera and both Jackpot and Mirage are as follows:

1. Mean leaf blade color rating of Riviera (8.4) is greater than that of Mirage (6.5) and Jackpot (6.4) indicating Riviera to have darker green color (Table B7).

2. Mean number of racemes per inflorescence of Riviera (4.2) is less than that of Jackpot (5.0) and Mirage (5.0) (Table B12).

3. Mean head exertion length of Riviera (19.1 mm) is less than that of Jackpot (33.3 mm) and Mirage (26.3 mm) (Table B14).

4. Mean peduncle length of Riviera (81.3 mm) is less than that of Jackpot (93.2 mm) and Mirage (91.4 mm) (Table B15).

Table B7. Mean leaf blade color ratings for Riviera, Mirage and Jackpot seed-propagated turf bermudagrass cultivars based on five measurements from each of 60 field grown plants in 1999 and 2000†. Rating scale was 1 to 9 where 1=light green and 9=dark green. Test located on the Agronomy Research Station, Stillwater, OK.

Cultivar	Leaf Blade Color Ratings				
	Means			Ranges	
	1999	2000	2 Yr. Mean	1999	2000
	Rating				
Riviera	8.2	8.6	8.4	6-9	6-9
Mirage	6.6	6.4	6.5	6-9	5-9
Jackpot	6.3	6.5	6.4	6-7	6-7
5% LSD*	1.2	1.1	0.8		

†Test planted June 1998. Plants arranged in a randomized complete block design with four replications. Whole plots were varieties and subplots were individual plants within cultivars. Measurements were taken on a total of 60 plants per cultivar i.e. 15 plants per cultivar per rep. Data were analyzed using the Statistical Analysis System PROC ANOVA procedure.

*Any two means within a column whose difference exceeds that of the LSD (Tukey's Least Significant Difference test) value are statistically different at the 0.05 probability level.

Table B12. Mean number of racemes per inflorescence for Riviera, Mirage and Jackpot seed-propagated turf bermudagrass cultivars based on five measurements from each of 60 field grown plants in 1999 and 2000†. Test located on the Agronomy Research Station, Stillwater, OK.

Cultivar	Racemes/Inflorescence				
	Means			Ranges	
	1999	2000	2 Yr. Mean	1999	2000
	No				
Jackpot	5.0	5.0	5.0	3-6	3-6
Mirage	5.0	5.0	5.0	4-6	4-7
Riviera	4.1	4.3	4.2	3-5	3-5
5% LSD*	0.6	0.5	0.5		

†Test planted June 1998. Plants arranged in a randomized complete block design with four replications. Whole plots were varieties and subplots were individual plants within cultivars. Measurements were taken on a total of 60 plants per cultivar i.e. 15 plants per cultivar per rep. Data were analyzed using the Statistical Analysis System PROC ANOVA procedure.

*Any two means within a column whose difference exceeds that of the LSD (Tukey's Least Significant Difference test) value are statistically different at the 0.05 probability level.

Table B14. Mean head exsertion length (mm) for Riviera, Mirage and Jackpot seed-propagated turf bermudagrass cultivars based on five measurements from each of 60 field grown plants in 1999 and 2000†. Measurements were from base of inflorescence to the flag leaf. Test located on the Agronomy Research Station, Stillwater, OK.

Cultivar	Head Exsertion Length (mm)				
	Means			Ranges	
	1999	2000	2 Yr. Mean	1999	2000
	mm				
Jackpot	32.4	34.2	33.3	0-96	0-94
Mirage	26.8	25.8	26.3	1-84	0-80
Riviera	17.6	20.6	19.1	0-75	0-79
5% LSD*	5.2	5.0	4.9		

†Test planted June 1998. Plants arranged in a randomized complete block design with four replications. Whole plots were varieties and subplots were individual plants within cultivars. Measurements were taken on a total of 60 plants per cultivar i.e. 15 plants per cultivar per rep. Data were analyzed using the Statistical Analysis System PROC ANOVA procedure.

*Any two means within a column whose difference exceeds that of the LSD (Tukey's Least Significant Difference test) value are statistically different at the 0.05 probability level.

Table B15. Mean peduncle length (mm) for Riviera, Mirage and Jackpot seed-propagated turf bermudagrass cultivars based on five measurements from each of 60 field grown plants in 1999 and 2000†. Measurements taken were from base of whorl to first node. Test located on the Agronomy Research Station, Stillwater, OK.

Cultivar	Peduncle Length (mm)				
	Means			Ranges	
	1999	2000	2 Yr. Mean	1999	2000
	mm				
Jackpot	94.9	91.5	93.2	30-165	11-150
Mirage	89.7	93.1	91.4	47-162	50-160
Riviera	83.1	79.5	81.3	16-84	21-86
5% LSD*	5.7	5.6	5.5		

†Test planted June 1998. Plants arranged in a randomized complete block design with four replications. Whole plots were varieties and subplots were individual plants within cultivars. Measurements were taken on a total of 60 plants per cultivar i.e. 15 plants per cultivar per rep. Data were analyzed using the Statistical Analysis System PROC ANOVA procedure.

*Any two means within a column whose difference exceeds that of the LSD (Tukey's Least Significant Difference test) value are statistically different at the 0.05 probability level.

EXHIBIT C
(Bermudagrass)

U. S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE
SCIENCE AND TECHNOLOGY
PLANT VARIETY PROTECTION OFFICE
BELTSVILLE, MD 20705

OBJECTIVE DESCRIPTION OF VARIETY
BERMUDAGRASS (Cynodon spp.)

NAME OF APPLICANT(S)	FOR OFFICIAL USE ONLY
Oklahoma Agricultural Experiment Station	PVPO NUMBER 200300221
ADDRESS (Street and No. or R.F.D. No., City, State, and ZIP Code)	VARIETY NAME
139 Agricultural Hall Stillwater, OK 74078-6019	Riviera
	TEMPORARY OR EXPERIMENTAL DESIGNATION
	OKS 95-1

Place the appropriate number that describes the varietal character of this variety in the spaces provided. Place a zero in the first box (e.g. 0/9/9 or 0/9/) when number is either 99 or less or 9 or less. The symbol "▲" indicates decimal. Characteristics described, including numerical measurements, should represent those that are TYPICAL for the variety. Comparisons to standard varieties must be made under the same conditions. Append all pertinent comparative trial and evaluation data. Measured data should be for unclipped spaced plants that represent the application variety, the most similar variety, and one standard cultivar, or replicated unclipped plots or individual unclipped pots if grown in a greenhouse. Data should be obtained from mature plants (specify age of plants when measured). A minimum of 30 plants and 60 data points should be used for all measurements. Specify growing conditions and experimental design. Give location of test area.

STANDARD CULTIVARS Use cultivars from same species and ploidy level

1 = Seeded Common	4 = Tifway	7 = Coastal	10 = other (Specify species)
2 = Guymon	5 = Tifgreen	8 = Coastcross-1	
3 = Mirage	6 = Midiron	9 = Giant	Jackpot, Cynodon dactylon

SPECIFIC VARIETIES USED FOR COMPARISON AS CHECK VARIETIES IN THIS APPLICATION: Use standard regional check varieties that are adapted to your area. One of the comparison varieties must be the most similar variety (MSV) used in Exhibit B.

MSV 1. Mirage Variety 2. Jackpot Variety 3. _____

1. SPECIES: (With comparison varieties for use below - use varieties within species of application variety)

[1]

1 = *C. dactylon var. dactylon*
2 = *C. dactylon var. aridus*
3 = *C. transvaalensis*
4 = *C. dactylon X C. transvaalensis*
5 = Other (Specify). _____

Is this an F_1 hybrid? _____
Is this for turf or forage use? _____
Is this seed or clonally propagated? _____

2. CYTOLOGY

[3][6] 2n Chromosome Number

10

20030021

Ploidy
1 = diploid
2 = tetraploid
3 = triploid
4 = Other (Specify)

	Application Variety	MSV Variety 1	Comparison Variety 2	Comparison Variety 3
	2	2	2	

3. ADAPTATION: (0= Not tested; 1= Inadequately Tested; 2= Not Adapted; 3 = Adapted)

1	Northwest	1	North Central	1	Northeast		Other
3	West Central	3	Central	3	East Central		Other
3	Southwest	3	South Central	3	Southeast		Other

4. RHIZOMES
1 = None (Coastcross -1)
4 = Weakly Rhizomatous (Coastal)
6 = Moderately Rhizomatous (Common)
9 = Heavy Rhizomatous

9	9	9	

Amount of spread in 1 year cm

90	90	90	

5. STOLONS AND SHOOTS:

Specify site, season and growing conditions: Stillwater; June through Sept., well fertilized & irrigated to maintain non-stressed conditions.

Anthocyanin pigmentation (cool temperature). Examples: **present** in Common, **absent** in Midland.

or
Percent of plants with anthocyanin pigmentation

60			

Stolon internode length cm. Measure from between 3rd and 4th fully extended nodes from apical meristem.

4.20	3.97	2.79	

Stolon internode diameter mm. Measure from center of 3rd fully extended internode from apical meristem.

1.11	1.38	1.19	

Number of growing points at a mature node. Recommend 4th node.

1.31	1.37	1.18	

Specify which node was counted.

4th	4th	4th	

Length of longest stolon cm

37.3	42.5	27.0	

20030027

Stolon length mm. Measure from the stolon apical meristem to the 5th node of the central stolon.

Application Variety	MSV Variety 1	Comparison Variety 2	Comparison Variety 3
194.9	187.9	145.9	

6. LEAF BLADE:

Color
1 = Light Green (Bayshore, Seeded Common),
3 = Light Medium Green,
5 = Medium Green (Guymon),
7 = Medium Dark Green (Everglades, Tifway),
9 = Dark Green (Tifgreen, Sunturf),

7	5	5	

Other Color
1 = Bluegreen (Tifdwarf, No Mow)
2 = Grey Green
3 = Other (specify)

Percent plants with other color

Width Class
1 = Very Coarse (Coastcross-1)
3 = Coarse (Midland, Guymon)
5 = Medium (Seeded Common)
7 = Fine (Tifway)
9 = Very Fine (Tifgreen)

7	5	5	

Leaf length cm. Measure longest leaf at third node below apical meristem on main upright tiller.

4.79	4.94	4.37	

Leaf width mm. Measurement on 3rd or 4th leaf below apical meristem. Measure width at widest part about 1 cm from base.

2.13	2.07	1.56	

Flag leaf length cm

2.17	2.49	2.31	

Flag leaf width mm. Measure width at widest part or about 1 cm from base.

1.25	1.14±	0.99	

Flag leaf sheath length mm

62.2	64.8	60.8	

Leaf width mm (lateral leaves). Measure the widest part of largest leaf at 4th node from tip of stolon.

2.22	2.59	2.55	

Leaf length cm (lateral leaves). Measure the longest part of largest leaf at 4th node from tip of stolon.

2.12	3.16	2.53	

Leaf blade hair number (use 1 = absent; several; 9 = abundant).

Application Variety	MSV Variety 1	Comparison Variety 2	Comparison Variety 3
Several	Several	Several	

Leaf blade hair length (use 1 = absent; 5=short; 9 = very long).

5	5	5	

Leaf sheath hair number (use 1 = absent; several; 9 = abundant).

Several	Several	Several	

Leaf sheath hair length (use 1 = absent; 5=short; 9 = very long).

5	5	5	

Leaf collar hair number (use 1 = absent; several; 9 = abundant).

Leaf collar hair length (use 1 = absent; 5=short; 9 = very long).

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7. INFLORESCENCE (Specify site, season, and growing conditions).

Inflorescence length cm. The length of the racemes on the inflorescence.

Application Variety	MSV Variety 1	Comparison Variety 2	Comparison Variety 3
4.54	4.48	4.36	

Number of racemes per inflorescence.

4.2	5.0	5.0	

Number of whorls per inflorescence.

1.0	1.02	1.0	

Percent of plants with more than one whorl of branches/inflorescence.

Percent of inflorescences with more than 1 whorl.

< 1	< 1	< 1	

Spikelets per raceme.

41.1	41.3	42.3	

Spikelet spacing on raceme mm Measured from bottom 1/3 of spike.

Raceme density [number of racemes/ $(0.2m)^2$]

	Application Variety	MSV Variety 1	Comparison Variety 2	Comparison Variety 3
Percent of plants with spike anthocyanin				
Stigma color % plants with white stigmas. Measure within 24 hours after anthesis.	90	10	50	
Stigma color % plants with light purple stigmas. Measure within 24 hours after anthesis.	5	20	30	
Stigma color % plants with purple stigmas. Measure within 24 hours after anthesis.	5	70	20	
Anther color % plants with purple anthers. Measure within 24 hours after anthesis.	80	65	100	
Anther color % plants with yellow anthers. Measure within 24 hours after anthesis.	20	35	0	
Anther color % plants with other (specify). Measure within 24 hours after anthesis.				
Head exertion cm. Measure from the base of the inflorescence to the flag leaf.	1.91	2.63	3.33	
Peduncle length cm. Measure internode from base of whorl to first node.	8.13	9.14	9.32	
First internode length cm.	3.91	5.07	5.08	
Flag leaf sheath length cm. Measure from node to flag leaf base.	6.22	6.48	6.08	

8. PLANT HEIGHT (Specify site, time, growing conditions).

Plant height cm. Measure at maturity, using the tallest inflorescence per plant and hold out to furthest extension for measurement.	50.8	55.12	42.23	
Vegetative height cm. Height of vegetation excluding seedheads, measure at seedhead maturity.	28.7	34.8	29.72	

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9. SEED, LEMMA, AND GLUME: Use seed harvested from PVP nursery, not commercial seed lots. 20030021

	Application Variety	MSV Variety 1	Comparison Variety 2	Comparison Variety 3
Glume length mm	1.6			
Glume width mm	0.2			
Lemma length mm	2.1			
Lemma width mm	0.1			
Glume/lemma length ratio	0.76			
Lemma keel hair number (use 1 = absent; 5=several; 9 = many).	5			
Lemma keel hair length (use 1 = absent; 5=short; 9 = very long).	5			
Lemma margin hair number (use 1 = absent; 5=several; 9 = many).	5			
Lemma margin hair length (use 1 = absent; 5=short; 9 = very long).	5			
Seed length mm (naked caryopses).	1			
Seed width mm (naked caryopses).	0.4			

Explain if samples are blown and unhulled or hulled. Blown and hulled

Weight of 100 seed mg	23			
Number of seeds per gram	4450			

10. LOW TEMPERATURE TOLERANCE (Winter hardiness)

1 = Low or 100% injury (Coastcross-1, Common)
4 = Moderately Low (Coastal, Brazos)
6 = Moderately High (Tifway, Guymon, Tifdwarf)
9 = High or no injury (Midiron, Midland)

Application Variety	MSV Variety 1	Comparison Variety 2	Comparison Variety 3
8	6	6	

11. DISEASES AND INSECTS
(0=Not Tested, 1=Susceptible, 2=Moderately susceptible, 3=Moderately resistant, 4=Resistant):

0	Brown patch *(Rhizotonia solani)*	0	Aphids
0	Dollar spot *(Sclerotinia homoeocarpa)*	0	Bermudagrass mite *(Eriophyes cynodoniensis)*
0	Fading out *(Curvularia spp.)*	0	Chinch bugs
3	Leafspot (*Bipolaris spp.*)	0	Ground pearl (scale)
0	Rusts *(Puccinia spp.)*	0	Grubs
2	Spring Dead Spot *(Pathogen indefinite)*	0	Thrips
0	Zonate leafspot *(D. gigantea)*	0	Whitefly
	Other: _____		Other: _____

12. INDICATE THE SEED PROPAGATED VARIETY THAT MOST CLOSELY RESEMBLES THE APPLICATION VARIETY FOR THE FOLLOWING CHARACTERS: For each of the following characters, indicate the degree of resemblance by placing in the column marked "D.R." one of the following numbers.

1 = Application variety is less than comparison variety.
2 = Same as.
3 = More than, better, greater, darker, etc.

CHARACTER	VARIETY	D.R.
Rate of Spread	Mirage	2
Sod Density	Princess 77	2
Color	Guymon	2
Cold Tolerance	Guymon	2

13. SPECIFY LOCATION, GROWING CONDITIONS, AND EXPERIMENTAL DESIGN BELOW. Include location, age of plants, date of data collection (with daylength if possible), management conditions, experimental design etc.). Attach more paper if needed.

All measurements taken at the Agronomy Research Station, Okla. St. Univ., Stillwater, OK. Plants (60 of each) of Riviera, Yukon, Arizona Common, Mirage, Jackpot, and NuMex Sahara were planted in the field in 1998 on a Kirkland silt loam soil. Data were taken during the 1999 and 2000 growing seasons. Plots were fertilized and irrigated as needed to maintain a good growth environment. Plants were arranged in a randomized complete block experimental design with split plots. Whole plots were varieties and sub-plots were plants within variety. Four replications of 15 plants per rep were used. The developmental stage of plants at time of measurement varied with the character being measured. Most measurements were taken on plants near or at heading stage. During summer 2002, 20 plants each of Riviera and Princess 77 were grown in 6" diameter pots in the greenhouse and used to collect data on morphological characters. Plants were arranged in a randomized complete block design with 20 reps i.e. 1 plant/variety/rep.

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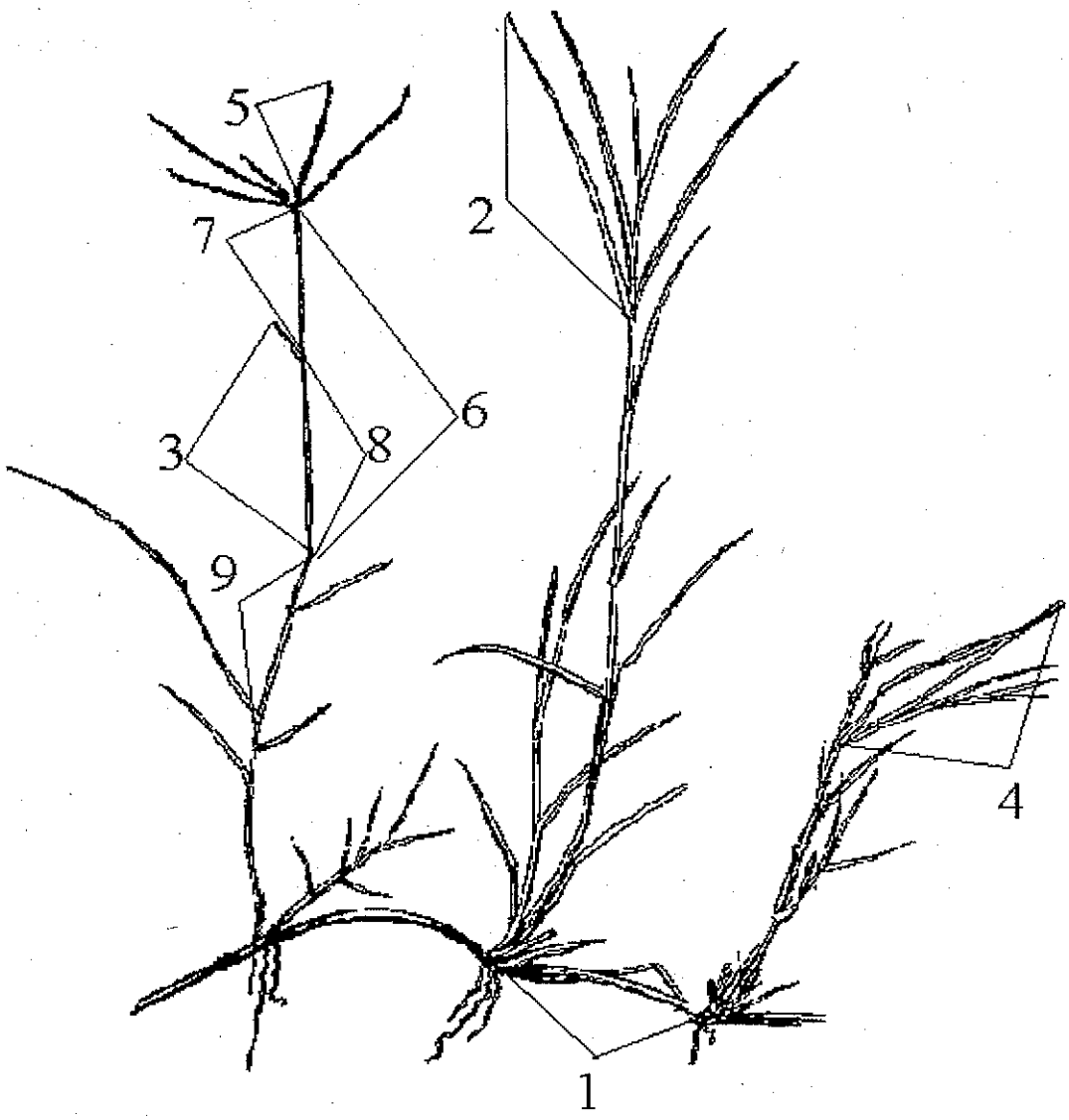

Bermuda grass *(Cynodon dactylon)*

1. Stolon internode length
2. First fully extended leaf of upright growth
3. Flag leaf length
4. First fully extended leaf from tip of stolon
5. Inflorescence length
6. Peduncle length
7. Head exsertion
8. Sheath length
9. First internode length

REFERENCE

Parker, Kittie F., An Illustrated Guide to Arizona Weeds. Drawings by Lucretia Breazeale Hamilton. Tucson, University of Arizona Press [1972]. xii, 338 p. illus.

18d. Exhibit D. Additional description of variety.

Riviera differs from selected seed-propagated turf bermudagrass varieties other than the two most similar varieties (Mirage and Jackpot) as follows:

1. Tolerance to low freezing temperatures is greater for Riviera (T_{mid} = -8.3 °C) compared to Princess (T_{mid} = -6.9 °C) (Table D1).

2. Riviera has faster spring greenup, a higher percentage of living ground cover in early spring, less winterkill, and lower winter injury than Princess, SWI-11, Transcontinental, Savannah, Southern Star, Blackjack, J-540, Majestic, Sydney, Sundevil II, Shangri La, Pyramid, Blue-Muda, Numex-Sahara, and Arizona Common seeded bermudagrass varieties as indicated by ratings from the 1997 National Turf Evaluation Program (NTEP) bermudagrass test (Table D2).

3. Riviera has better turfgrass quality than Princess, SWI-11, Transcontinental, Savannah, Southern Star, Blackjack, J-540, Majestic, Sydney, Sundevil II, Shangri La, Pyramid, Blue-Muda, Numex-Sahara, and Arizona Common seeded bermudagrass varieties as indicated by ratings from the 1997 NTEP bermudagrass test for Management Schedule B (Table D3). Riviera turfgrass quality is superior to all seeded bermudagrass varieties except Princess under Management Schedule A (Table D3).

4. Mean stolon internode diameter of Riviera (1.11 mm) is less than that of Guymon 92.04 mm), Yukon (1.35 mm), and Arizona Common (1.33 mm) seeded bermudagrass varieties (Table D4).

5. Mean stolon internode length of Riviera (41.98 mm) is shorter than that of Arizona Common (46.7 mm) and longer than that of Guymon (34.95 mm) and and Yukon (31.55 mm) (Table D5).

6. Mean number of growing points emanating from the 4th node of mature stolons of Riviera (1.31) is less than that of Arizona Common (1.21), Yukon (1.16) and Guymon (1.09) (Table D6).

7. Mean number of growing points emanating from the 4th node of mature stolons of Riviera (1.26) is less than that of Princess (1.56) (Table D7).

8. Mean stolon length of Riviera (194.9 mm) is less than that of Arizona Common (215.6 mm) and greater than that of Guymon (171.1 mm) and Yukon (146.3 mm) (Table D8).

9. Riviera has darker green leaves than Guymon, Yukon, Arizona Common, and NuMex Sahara (Table D9)

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10. Mean leaf width of Riviera (2.13 mm) is less than that of Guymon (3.29 mm) and greater than that of Arizona Common (1.87 mm) and NuMex Sahara (1.76 mm) (Table D10).

11. Mean leaf width of Riviera (2.5 mm) is greater than that of Princess (2.22 mm) (Table D11).

12. Mean leaf length of Riviera (47.9 mm) is less than that of Guymon (76.9 mm), and NuMex Sahara (60.4 mm) (Table D12).

13. Mean leaf length of Riviera (37.95 mm) is less than that of Princess (18.79 mm) based on measurements of greenhouse grown plants (Table D13).

14. Mean flag leaf width of Riviera (1.25 mm) is less than that of Guymon (1.74 mm) and Yukon (1.33 mm), and greater than that of Arizona Common (1.15 mm) and NuMex Sahara (1.05 mm) (Table D14).

15. Mean flag leaf length of Riviera (21.7 mm) is less than that of Guymon (40.5 mm), NuMex Sahara (30.2 mm) and Arizona Common (26.7 mm) (Table D15).

16. Mean lateral leaf width of Riviera (2.22 mm) is less than that of NuMex Sahara (2.68 mm), Arizona Common (2.63 mm), and Guymon (2.56 mm), and greater than that of Yukon (2.02 mm) (Table D16).

17. Mean lateral leaf width of Riviera (2.45 mm) is less than that of Princess (2.21 mm) based on measurements of greenhouse grown plants (Table D17).

18. Mean lateral leaf length of Riviera (21.2 mm) is less than that of Yukon (34 mm), Arizona Common (33.4 mm), NuMex Sahara (33.1 mm), and Guymon (25.6 mm) (Table D18).

19. Density of leaf hairs on leaf blades, leaf sheaths, and collars is less on Riviera than on Guymon (Table D19).

20. Mean inflorescence length of Riviera (45.4 mm) is shorter than that of Guymon (60.7 mm) and NuMex Sahara (48.6 mm) and longer than that of Arizona Common (43.3 mm) (Table D20).

21. Mean number of racemes per inflorescence for Riviera (4.2) is less that that of Guymon (5.7), Yukon (5.4), NuMex Sahara (5.1) and Arizona Common (5) (Table D21).

22. Mean number of raceme whorls per inflorescence for Riviera (1) is less than that of Yukon (1.06) and Guymon (1.04) (Table D22).

23. Mean number of spikelets per raceme for Riviera (41.1) is less than that of Guymon (51.6) and NuMex Sahara (43.2) and greater than that of Arizona Common (39.0) and Yukon (35.4) (Table D23).

24. Rivera has a greater percentage of plants with white stigmas and lower percentages of plants with light purple or purple stigmas than Guymon, NuMex Sahara, Arizona Common, and Yukon. Riviera has a slightly higher percentage of plants bearing yellow anthers and a slightly lower percentage of plants bearing purple anthers than Guymon, NuMex Sahara, and Yukon. Riviera has much higher and lower percentages of plants with yellow and purple anthers, respectively, than Arizona Common (Table D24).

25. Mean head exertion length of Riviera (19.1 mm) is less than that of Guymon (39.4 mm) and NuMex Sahara (24.9 mm) and greater than that of Yukon (14.6 mm) (Table D25).

26. Mean peduncle length of Riviera (81.3 mm) is less than that of Guymon (133.5 mm) and NuMex Sahara (99.2 mm), and greater than that of Yukon (69.7 mm) (Table D26).

27. Mean 1st internode length of seed stalks of Riviera (39.1 mm) is less than that of Guymon (97 mm) and NuMex Sahara (57.4 mm) (Table D27).

28. Mean flag leaf sheath length of Riviera (62.2 mm) is less than that of Guymon (97.0 mm) and NuMex Sahara (73.9 mm) and greater than that of Yukon (54.1 mm) (Table D28).

29. Mean mature plant height of Riviera (508 mm) is less than that of Guymon (638.8 mm), Arizona Common (604.5 mm), and NuMex Sahara (564.5 mm) and greater than that of Yukon (411.1 mm) (Table D29).

30. Mean mature vegetative plant height of Riviera (287 mm) is less than that of Guymon (414 mm), NuMex Sahara (363.2 mm), and Arizona Common 9340.4 mm) (Table D30).

31. DNA profiling easily differentiated Riviera from the following seeded varieties: Mirage, Jackpot, Arizona Common, CD90160, Mohawk, Savannah, Southern Star, Sundevil, NuMex Sahara, Sydney, Pyramid, Transcontinental, Majestic, Riviera, Princess, SWI-11, and Yukon (See attached manuscript entitled 'DNA Fingerprinting of Seeded Bermudagrass Cultivars' by Praveen Nagh Yerramsetty, Michael P. Anderson, Charles M. Taliaferro and Dennis L. Martin. The manuscript has been accepted for publication in Crop Science and is in press as of Oct. 2004).

Table D1. Relative freeze tolerance of turf bermudagrass varieties as determined by laboratory analyses. T_{mid} values represent the midpoint of the survival-temperature response curve. Data from: Anderson, J, C. Taliaferro, D. Martin. Longer exposure durations increase freeze damage to turf bermudagrasses. Crop Sci. (In press).

Variety	Type	T_{mid} (°C)
Tifway	Clonal	-7.9 b*
TifSport	Clonal	-7.9 b
Midlawn	Clonal	-10.3 e
U-3	Clonal	-8.9 cd
Patriot	Clonal	-9.7 de
Princess	Seeded	-6.9 a
Riviera	Seeded	-8.3 bc

*Means within a column followed by the same letter are not significant at the 0.05 probability level as determined by Duncan's Multiple Range test.

Table D2. Mean ratings for varieties in the National Turfgrass Evaluation Program bermudagrass test-1997 for traits related to winter hardiness.[1]

Variety	Spring Greenup[2]	% Living Ground Cover (Spring)[3]	% Winterkill[4]	Winter Injury Ratings[5]
Seeded Varieties				
Riviera	6.3	90.4	18.1	7.0
Princess	5.0	67.3	62.4	2.3
SWI-11	3.8	63.8	68.8	2.0
Transcontinental	5.2	77.6	41.3	4.3
Savannah	4.6	64.9	64.6	2.3
Southern Star	4.7	67.7	50.3	3.0
Blackjack	4.7	74.0	26.9	4.7
J-540	4.4	59.9	54.4	2.7
Majestic	3.9	58.2	66.7	1.7
Sydney	4.3	63.7	57.9	1.3
Sundevil II	4.4	64.0	57.0	3.0
Shangri La	4.1	57.6	58.2	1.7
Pyramid	4.2	58.6	59.7	2.0
Blue-Muda	4.4	58.4	57.3	1.7
Mirage	4.1	60.7	43.3	1.7
Numex-Sahara	4.1	54.1	51.8	1.7
Jackpot	4.3	58.7	58.7	2.0
Arizona Common	3.7	45.2	50.0	1.7
LSD 0.05	.03	6.9	12.2	1.3
CV (%)	35.8	37.3	32.3	31.5
Vegetative Varieties				
TifSport	4.8	71.4	35.4	3.7
Tifway	5.0	76.8	41.4	2.7
Tifgreen	5.5	78.7	43.5	4.0
Patriot	5.4	84.0	15.5	6.7
CN 2-9	5.0	70.1	34.7	2.3
Midlawn	6.1	85.9	14.8	5.7
OKC 19-9	5.9	79.9	11.8	6.3
Shanghai	5.3	77.8	29.8	5.3
Mini-Verde	4.3	59.3	62.7	3.0
Cardinal	6.3	87.0	11.5	5.0
LSD 0.05	0.3	5.5	10.4	2.3
CV (%)	32.8	24.8	47.9	32.7

[1]Source: Morris, K. N. 2002. National Bermudagrass Test- 1997, Final Report 1997-2001, NTEP No. 02-7. National Turfgrass Evaluation Program, Beltsville Agricultural Research Center-West, Bldg. 003, Rm 218, Beltsville, MD. [2]Mean of 14 locations. [3]Mean of 14 locations. [4]Mean of four northern locations, Fayetteville, AR, Wichita, KS, Columbia, MO, and Stillwater, OK. [5]Winter injury ratings at Wichita, KS. Ratings on a scale of 1 to 9, 9=no injury.

Table D3. Mean (1997-2001) turfgrass quality ratings of bermudagrass varieties in the National Turfgrass Evaluation Program bermudagrass test – 1997. Ratings are on a scale of 1 to 9, with 9 representing ideal turf quality.*

Variety	Management Schedule[2]		Avg.
	A	B	
Seeded Varieties			
Riviera	6.4	6.6	6.5
Princess	6.5	6.1	6.3
SWI-11	6.1	5.5	5.8
Transcontinental	6.0	5.6	5.7
Savannah	5.4	5.3	5.3
Southern Star	5.4	5.4	5.3
Blackjack	5.3	5.4	5.2
J-540	5.3	5.2	5.2
Majestic	5.3	5.3	5.2
Sydney	5.2	5.2	5.2
Sundevil II	5.3	5.0	5.1
Shangri La	5.2	5.1	5.1
Pyramid	5.2	5.0	5.0
Blue-Muda	5.1	5.0	5.0
Mirage	5.1	4.9	5.0
Numex-Sahara	5.0	5.0	4.9
Jackpot	5.0	4.9	4.9
Arizona Common	4.7	4.5	4.6
LSD 0.05	0.2	0.2	0.1
CV (%)	12.7	15.4	14.5
Vegetative Varieties			
TifSport	6.5	6.1	6.4
Tifway	6.4	6.2	6.3
Tifgreen	6.1	6.3	6.2
Patriot	6.1	6.6	6.3
CN 2-9	6.1	5.8	5.9
Midlawn	5.8	6.5	6.1
OKC 19-9	5.8	6.1	5.9
Shanghai	5.6	6.1	5.9
Mini-Verde	5.6	5.1	5.4
Cardinal	5.4	5.7	5.5
LSD 0.05	0.2	0.2	0.1
CV (%)	15.8	14.2	14.5

*Source: Morris, K. N. 2002. National Bermudagrass Test- 1997, Final Report 1997-2001, NTEP No. 02-7. National Turfgrass Evaluation Program, Beltsville Agricultural Research Center-West, Bldg. 003, Rm 218, Beltsville, MD.

[2]Schedule A= ½ to ¾ inch mowing height, ¾ to 1 lb N/1000 ft^2/growing month, irrigation to prevent visual drought stress, and mowing frequency 3 to 5 times/week. Data from nine test locations. Schedule B= ¾ to 1 inch mowing height, ½ to ¾ lb N/1000 ft^2/growing month, irrigation to prevent dormancy, and mowing frequency 1-2 times/week. Data from 12 test locations.

Table D4. Mean stolon internode diameter for seven field grown seed-propagated turf bermudagrass varieties based on five measurements from each of 60 plants. Measurements taken from center of 3rd fully extended internode from the apical meristem. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Stolon Internode Diameter	
	Mean	Range
	---------- mm ----------	
Guymon	2.04 a*	1.02 – 2.61
Mirage	1.38 b	1.02 – 2.29
Yukon	1.35 b	0.76 – 2.03
Arizona Common	1.33 b	0.76 – 2.03
NuMex Sahara	1.28 bc	0.76 – 1.79
Jackpot	1.19 bc	0.76 – 1.79
Riviera	1.11 c	0.76 - 1.79

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D5. Mean stolon internode length for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Measured at 3rd fully extended internode from the meristem. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Stolon Internode Length	
	Mean	Range
	---------- mm ----------	
Arizona Common	46.70 a*	12.00 – 159.00
NuMex Sahara	43.99 ab	13.00 – 89.00
Riviera	41.98 bc	10.00 – 79.00
Mirage	39.65 c	10.00 – 114.00
Guymon	34.95 d	8.00 – 125.00
Yukon	31.55 d	8.00 – 105.00
Jackpot	27.86 e	6.00 – 73.00

*Means followed by the same letter are not statistically different based on the 5% LSD.

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Table D6. Mean number of growing points emanating from the 4th node of mature stolons of seven field grown seed-propagated turf bermudagrasses based on five measurements from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Growing Points/4th Node	
	Mean	Range
	---------- No ----------	
Mirage	1.37 a*	1.00 – 3.00
NuMex Sahara	1.32 a	1.00 – 2.00
Rivera	1.31 a	1.00 – 2.00
Arizona Common	1.21 b	1.00 – 2.00
Jackpot	1.18 bc	1.00 – 2.00
Yukon	1.16 bc	1.00 – 2.00
Guymon	1.09 c	1.00 – 2.00

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D7. Mean number of growing points emanating from the 4th node of mature stolons of 'Princess' and 'Riviera' seed-propagated turf bermudagrasses based on five measurements from each of 60 plants grown in the greenhouse. Okla. St. Univ. Agron. Res. Stn., Stillwater, OK. 2002.

Variety	Growing Points/4th Node	
	Mean	Range
	---------- No. ----------	
Princess	1.56 a	0.00 – 7.00
Riviera	1.26 b	0.85 – 4.00

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D8. Mean stolon length for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Stolon length measured from the apical meristem to the 5th node. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Stolon length	
	Mean	Range
	---------- mm ----------	
Arizona Common	215.6 a*	99 – 582
NuMex Sahara	206.2 ab	108 – 363
Riviera	194.9 bc	79 - 373
Mirage	187.9 c	69 – 425
Guymon	171.1 d	73 – 390
Yukon	146.3 e	60 – 363
Jackpot	145.9 e	82 - 270

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D9. Mean leaf blade color ratings for seven field grown seed-propagated bermudagrass varieties based on five ratings from each of 60 plants. Rating scale was 1 = light green; 9 = dark green. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Rating	
	Mean	Range
Riviera	8.4 a*	6 - 9
Guymon	7.7 b	7 – 9
Yukon	7.4 b	6 – 9
Mirage	6.5 c	5 – 9
Jackpot	6.4 c	6 – 7
Arizona Common	6.3 c	5 – 7
NuMex Sahara	5.6 d	3 - 7

*Means followed by the same letter are not statistically different based on the 5% LSD.

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Table D10. Mean leaf width for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Leaf width was measured on first fully extended leaf of upright growth at widest part. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Leaf width	
	Mean	Range
	---------- mm ----------	
Guymon	3.29 a*	2.03 – 5.33
Yukon	2.36 b	1.27 – 3.30
Riviera	2.13 c	1.52 – 3.05
Mirage	2.07 c	1.27 – 2.94
Arizona Common	1.87 d	1.27 – 2.54
NuMex Sahara	1.76 e	1.27 – 2.54
Jackpot	1.56 f	1.01 – 2.79

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D11. Mean leaf width for 'Princess' and 'Riviera' seed-propagated bermudagrass varieties based on five measurements from each of 20 greenhouse grown plants. Leaf width was measured on first fully extended leaf of upright growth at widest part. Okla. St. Univ. Agron. Res. Stn., Stillwater, OK. 2002.

Variety	Leaf width	
	Mean	Range
	---------- mm ----------	
Princess	2.22 a*	1.00 – 3.00
Riviera	2.50 b	1.80 – 3.10

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D12. Mean leaf length for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Leaf length was measured on first fully extended leaf of upright growth. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Leaf length	
	Mean	Range
	---------- mm ----------	
Guymon	76.9 a*	26 – 214
NuMex Sahara	60.4 b	17 – 135
Arizona Common	52.2 c	17 – 120
Mirage	49.4 cd	15 – 110
Riviera	47.9 cde	25 - 93
Yukon	47.1 de	18 – 75
Jackpot	43.7 e	12 - 109

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D13. Mean leaf length for 'Princess' and 'Riviera' seed-propagated bermudagrass varieties based on five measurements from each of 20 greenhouse grown plants. Leaf length was measured on first fully extended leaf of upright growth. Okla. St. Univ. Agron. Res. Stn., Stillwater, OK. 2002.

Variety	Leaf length	
	Mean	Range
	---------- mm ----------	
Princess	18.79 a*	2.00 – 99.00
Riviera	37.95 b	9.00 – 115.00

*Means followed by the same letter are not statistically different based on the 5% LSD.

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Table D14. Mean flag leaf width for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Width measured at widest part of leaf. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Flag leaf width	
	Mean	Range
	mm	
Guymon	1.74 a*	0.76 – 3.81
Yukon	1.33 b	0.76 – 2.03
Riviera	1.25 c	0.76 – 2.03
Arizona Common	1.15 d	0.76 – 2.03
Mirage	1.14 d	0.51 – 2.29
NuMex Sahara	1.05 e	0.76 – 1.78
Jackpot	0.99 e	0.76 – 2.03

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D15. Mean flag leaf length for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Flag leaf length	
	Mean	Range
	mm	
Guymon	40.5 a*	5 – 144
NuMex Sahara	30.2 b	5 – 90
Arizona Common	26.7 c	5 – 65
Mirage	24.9 cd	5 – 93
Jackpot	23.1 de	4 – 80
Riviera	21.7 de	6 – 50
Yukon	20.3 e	6 - 61

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D16. Mean lateral leaf width for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Measurements taken at widest part of the first fully extended leaf from tip of stolon. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Lateral leaf width	
	Mean	Range
	---------- mm ----------	
NuMex Sahara	2.68 a*	1.52 – 3.81
Arizona Common	2.63 ab	1.78 – 3.30
Mirage	2.59 ab	1.52 – 3.56
Guymon	2.56 ab	0.76 – 5.33
Jackpot	2.55 b	1.01 – 3.81
Riviera	2.22 c	1.27 – 3.04
Yukon	2.02 d	0.76 – 3.81

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D17. Mean lateral leaf width for 'Princess' and 'Riviera' seed-propagated bermudagrass varieties based on five measurements from each of 60 greenhouse grown plants. Measurements taken at widest part of the first fully extended leaf from tip of stolon. Okla. St. Univ. Agronomy Res. Stn., 2002.

Variety	Lateral leaf width	
	Mean	Range
	---------- mm ----------	
Princess	2.21 a*	1.00 – 3.00
Riviera	2.45 b	2.00 – 3.10

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D18. Mean lateral leaf length for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Measured the first fully extended leaf from tip of stolon. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Lateral leaf length	
	Mean	Range
	---------- mm ----------	
Yukon	34.0 a*	3.0 – 126.2
Arizona Common	33.4 a	16.5 – 58.9
NuMex Sahara	33.1 a	9.4 – 91.2
Mirage	31.6 a	11.9 – 73.7
Guymon	25.6 b	5.3 – 128.8
Jackpot	25.3 b	10.2 – 64.0
Rivera	21.2 c	7.6 – 45.5

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D19. Mean ratings of leaf hair density for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000. Rating scale: 1= least dense hairs, 9=most dense hairs.

Variety	Leaf Blade		Sheath		Collar	
	Mean	Range	Mean	Range	Mean	Range
Guymon	5.9 a*	1 – 9	3.8 a	1 – 6	4.6 a	1 – 7
Riviera	1.5 b	1 - 6	1.8 b	1 – 6	2.3 b	1 – 6
Arizona Common	1.5 b	1 – 5	1.9 b	1 – 6	2.5 b	1 – 7
Yukon	1.4 b	1 – 5	1.8 b	1 – 7	2.4 b	1 - 6
NuMex Sahara	1.4 b	1 – 2	1.7 b	1 – 6	2.1 b	1 - 6
Mirage	1.3 b	1 – 2	1.6 b	1 – 6	2.2 b	1 – 6
Jackpot	1.3 b	1 - 3	1.5 b	1 – 5	2.1 b	1 – 6

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D20. Mean inflorescence length for seven seed-propagated turf bermudagrass varieties based on measurements from five inflorescences from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Inflorescence length	
	Mean	Range
	---------- mm ----------	
Guymon	60.7 a*	29 – 84
NuMex Sahara	48.6 b	25 – 75
Riviera	45.4 c	30 - 62
Mirage	44.8 cd	25 – 70
Yukon	43.8 cd	15 – 67
Jackpot	43.6 cd	20 – 65
Arizona Common	43.3 d	24 - 70

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D21. Mean number of racemes per inflorescence for seven field grown seed-propagated bermudagrass varieties based on measurements from five inflorescences from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Number of racemes/inflorescence	
	Mean	Range
	---------- Number----------	
Guymon	5.7 a*	3 – 9
Yukon	5.4 b	3 – 9
NuMex Sahara	5.1 c	4 – 6
Jackpot	5.0 c	3 – 6
Arizona Common	5.0 c	3 – 8
Mirage	5.0 c	4 – 7
Riviera	4.2 d	3 - 5

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D22. Mean number of raceme whorls per inflorescence for seven field grown seed-propagated bermudagrass varieties based on measurements from five inflorescences from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Number of raceme whorls/inflorescence	
	Mean	Range
	---------- Number----------	
Yukon	1.06 a*	1 – 2
Guymon	1.04 ab	1 – 2
Arizona Common	1.03 abc	1 – 2
Mirage	1.02 bc	1 – 2
Jackpot	1.00 c	1 – 1
NuMex Sahara	1.00 c	1 - 1
Riviera	1.00 c	1 - 1

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D23. Mean number of spikelets per raceme for seven field grown seed-propagated bermudagrass varieties based on measurements from five inflorescences from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Number of spikelets/ raceme	
	Mean	Range
	---------- Number----------	
Guymon	51.6 a*	24 – 74
NuMex Sahara	43.2 b	20 – 65
Jackpot	42.3 bc	17 – 63
Mirage	41.3 c	16 – 67
Riviera	41.1 c	24 - 57
Arizona Common	39.0 d	24 – 63
Yukon	35.4 e	14 - 53

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D24. Mean percentage plants based on stigma and anther color for seven field grown seed-propagated bermudagrass varieties based on measurements from five inflorescences from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Stigma color			Anther color	
	White	Light Purple	Purple	Yellow	Purple
	% if plants				
Rivera	90	5	5	80	20
Guymon	10	20	70	75	25
NuMex Sahara	40	35	25	65	35
Jackpot	50	30	20	100	0
Mirage	10	20	70	65	35
Arizona Common	15	35	50	15	85
Yukon	75	10	15	90	10

Table D25. Mean head exsertion length for seven field grown seed-propagated bermudagrass varieties based on measurements from five inflorescences from each of 60 plants. Measurements from base of inflorescence to the flag leaf. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Head exsertion length	
	Mean	Range
	mm	
Guymon	39.4 a*	1 – 107
Jackpot	33.3 b	0 – 96
Mirage	26.3 c	0 – 84
NuMex Sahara	24.9 c	0 – 97
Arizona Common	22.3 cd	0 – 78
Riviera	19.1 d	0 - 79
Yukon	14.6 e	0 - 63

*Means followed by the same letter are not statistically different based on the 5% LSD.

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Table D26. Mean peduncle length for seven field grown seed-propagated bermudagrass varieties based on measurements from five inflorescences from each of 60 plants. Measurements from base of whorl to first node. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Mean peduncle length	
	Mean	Range
	---------- mm ----------	
Guymon	133.5 a*	16 – 231
NuMex Sahara	99.2 b	58 – 182
Jackpot	93.2 c	11 – 165
Mirage	91.4 cd	47 – 162
Arizona Common	86.3 de	47 – 156
Riviera	81.3 e	16 - 86
Yukon	69.7 f	18 - 122

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D27. Mean first internode length of seed stalks for seven field grown seed-propagated bermudagrass varieties based on measurements from five shoots from each of 60 plants. Measurements made on first internode below inflorescence. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	First internode length	
	Mean	Range
	---------- mm ----------	
Guymon	97.0 a*	20 –232
NuMex Sahara	57.4 b	27 – 120
Jackpot	50.8 c	15 – 80
Mirage	50.7 c	25 – 93
Arizona Common	42.1 d	19 – 83
Riviera	39.1 de	16 - 86
Yukon	37.0 e	13 - 69

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D28. Mean flag leaf sheath length for seven field grown seed-propagated bermudagrass varieties based on measurements from five seed stalks from each of 60 plants. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Flag leaf sheath length	
	Mean	Range
	---------- mm ----------	
Guymon	97.0 a*	51 – 164
NuMex Sahara	73.9 b	46 – 139
Mirage	64.8 c	40 – 93
Arizona Common	63.8 cd	29 – 107
Riviera	62.2 cd	40 - 87
Jackpot	60.8 d	24 – 123
Yukon	54.1 e	15 - 80

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table D29. Mean mature plant height for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Measurements made by selecting tallest seed stalks and measuring from soil line to tip of inflorescence. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Plant height	
	Mean	Range
	---------- mm ----------	
Guymon	638.8 a*	406 - 787
Arizona Common	604.5 ab	432 – 787
NuMex Sahara	564.5 bc	381 – 711
Mirage	551.2 cd	356 – 762
Riviera	508.0 d	356 - 737
Jackpot	422.3 e	229 – 572
Yukon	411.1 e	127 - 533

*Means followed by the same letter are not statistically different based on the 5% LSD.

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Table D30. Mean mature vegetative plant height for seven field grown seed-propagated bermudagrass varieties based on five measurements from each of 60 plants. Measurements made from soil line to top of vegetative canopy. Okla. St. Univ. Agronomy Res. Stn., Stillwater, OK. 2000.

Variety	Vegetative plant height	
	Mean	Range
	---------- mm ----------	
Guymon	414.0 a*	279 – 533
NuMex Sahara	363.2 b	304 – 432
Mirage	348.0 b	178 – 457
Arizona Common	340.4 b	203 – 559
Jackpot	297.2 c	152 – 381
Yukon	292.1 c	51 – 483
Riviera	287.0 c	229 - 432

*Means followed by the same letter are not statistically different based on the 5% LSD.

Table B1. Mean ratings for varieties in the National Turfgrass Evaluation Program bermudagrass test-1997 for traits related to winter hardiness.[1]

Variety	Spring Greenup[2]	% Living Ground Cover (Spring)[3]	% Winterkill[4]	Winter Injury Ratings[5]
Seeded Varieties				
Riviera	6.3	90.4	18.1	7.0
Princess	5.0	67.3	62.4	2.3
SWI-11	3.8	63.8	68.8	2.0
Transcontinental	5.2	77.6	41.3	4.3
Savannah	4.6	64.9	64.6	2.3
Southern Star	4.7	67.7	50.3	3.0
Blackjack	4.7	74.0	26.9	4.7
J-540	4.4	59.9	54.4	2.7
Majestic	3.9	58.2	66.7	1.7
Sydney	4.3	63.7	57.9	1.3
Sundevil II	4.4	64.0	57.0	3.0
Shangri La	4.1	57.6	58.2	1.7
Pyramid	4.2	58.6	59.7	2.0
Blue-Muda	4.4	58.4	57.3	1.7
Mirage	4.1	60.7	43.3	1.7
Numex-Sahara	4.1	54.1	51.8	1.7
Jackpot	4.3	58.7	58.7	2.0
Arizona Common	3.7	45.2	50.0	1.7
LSD 0.05	.03	6.9	12.2	1.3
CV (%)	35.8	37.3	32.3	31.5
Vegetative Varieties				
TifSport	4.8	71.4	35.4	3.7
Tifway	5.0	76.8	41.4	2.7
Tifgreen	5.5	78.7	43.5	4.0
Patriot	5.4	84.0	15.5	6.7
CN 2-9	5.0	70.1	34.7	2.3
Midlawn	6.1	85.9	14.8	5.7
OKC 19-9	5.9	79.9	11.8	6.3
Shanghai	5.3	77.8	29.8	5.3
Mini-Verde	4.3	59.3	62.7	3.0
Cardinal	6.3	87.0	11.5	5.0
LSD 0.05	0.3	5.5	10.4	2.3
CV (%)	32.8	24.8	47.9	32.7

[1]Source: Morris, K. N. 2002. National Bermudagrass Test- 1997, Final Report 1997-2001, NTEP No. 02-7. National Turfgrass Evaluation Program, Beltsville Agricultural Research Center-West, Bldg. 003, Rm 218, Beltsville, MD. [2]Mean of 14 locations. [3]Mean of 14 locations. [4]Mean of four northern locations, Fayetteville, AR, Wichita, KS, Columbia, MO, and Stillwater, OK. [5]Winter injury ratings at Wichita, KS. Ratings on a scale of 1 to 9, 9=no injury.

Table B2. Mean (1997-2001) turfgrass quality ratings of bermudagrass varieties in the National Turfgrass Evaluation Program bermudagrass test – 1997. Ratings are on a scale of 1 to 9, with 9 representing ideal turf quality.*

Variety	Management Schedule[2]		Avg.
	A	B	
Seeded Varieties			
Riviera	6.4	6.6	6.5
Princess	6.5	6.1	6.3
SWI-11	6.1	5.5	5.8
Transcontinental	6.0	5.6	5.7
Savannah	5.4	5.3	5.3
Southern Star	5.4	5.4	5.3
Blackjack	5.3	5.4	5.2
J-540	5.3	5.2	5.2
Majestic	5.3	5.3	5.2
Sydney	5.2	5.2	5.2
Sundevil II	5.3	5.0	5.1
Shangri La	5.2	5.1	5.1
Pyramid	5.2	5.0	5.0
Blue-Muda	5.1	5.0	5.0
Mirage	5.1	4.9	5.0
Numex-Sahara	5.0	5.0	4.9
Jackpot	5.0	4.9	4.9
Arizona Common	4.7	4.5	4.6
LSD 0.05	0.2	0.2	0.1
CV (%)	12.7	15.4	14.5
Vegetative Varieties			
TifSport	6.5	6.1	6.4
Tifway	6.4	6.2	6.3
Tifgreen	6.1	6.3	6.2
Patriot	6.1	6.6	6.3
CN 2-9	6.1	5.8	5.9
Midlawn	5.8	6.5	6.1
OKC 19-9	5.8	6.1	5.9
Shanghai	5.6	6.1	5.9
Mini-Verde	5.6	5.1	5.4
Cardinal	5.4	5.7	5.5
LSD 0.05	0.2	0.2	0.1
CV (%)	15.8	14.2	14.5

*Source: Morris, K. N. 2002. National Bermudagrass Test- 1997, Final Report 1997-2001, NTEP No. 02-7. National Turfgrass Evaluation Program, Beltsville Agricultural Research Center-West, Bldg. 003, Rm 218, Beltsville, MD.

[2]Schedule A= ½ to ¾ inch mowing height, ¾ to 1 lb N/1000 ft^2/growing month, irrigation to prevent visual drought stress, and mowing frequency 3 to 5 times/week. Data from nine test locations. Schedule B= ¾ to 1 inch mowing height, ½ to ¾ lb N/1000 ft^2/growing month, irrigation to prevent dormancy, and mowing frequency 1-2 times/week. Data from 12 test locations.

DNA Fingerprinting of Seeded Bermudagrass Cultivars

Praveen Nagh Yerramsetty, Michael P. Anderson* Charles M. Taliaferro and Dennis L. Martin

P. N. Yerramsetty, M. P. Anderson and C.M. Taliaferro, Dept of Plant and Soil Sciences, Oklahoma State Univ., Stillwater, OK 74078; D. L. Martin, Dept of Horticulture and Landscape Architecture, Oklahoma State University, Stillwater, OK 74078.

Approved for publication by the Director, Okla. Agric. Exp. Stn. Research supported by the Oklahoma Agric. Exp. Stn. and the United States Golf Association.

Received _____

*Corresponding author (mpa@mail.pss.okstate.edu)

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ABSTRACT

Bermudagrasses *(Cynodon spp.)* are important for turf and forage in temperate and tropical climates, with cultivars historically propagated clonally. Over the past two decades the number of seed-propagated commercial cultivars has dramatically increased, but information is lacking on the extent of the genetic diversity among these new cultivars. Accordingly, this research was undertaken to assess the genetic relatedness of 17 seed-propagated turf-bermudagrass cultivars using DNA amplification fingerprinting (DAF). Four DAF and four Minihairpin-DAF (MHP-DAF) primers were used in this study. The DAF and MHP-DAF primers amplified 90 and 131 amplicons, respectively. A total of 13 out of the 17 cultivars were practically indistinguishable using the DAF primers with an average similarity (SC) of 0.982, while the MHP-DAF primers distinguished all cultivars readily. Results from the DAF and MHP-DAF analysis indicated that 14 out of the 17 cultivars were related to Arizona common germplasm with average SC of 0.833 in the MHP-DAF analysis. Arizona common germplasm is naturalized to the Colorado River Valley production areas of Arizona and California. The three most distinct cultivars: 'Princess 77', 'Yukon' and 'SWI-11' had an average SC of 0.668. The most distinct cultivar was 'Yukon' with an average SC of 0.604. Yukon showed 59 DNA signatures not observed in the other varieties studied with DAF and MHP-DAF. These results indicated that a majority of seeded-type bermudagrasses developed over the past two decades depend upon a narrow genetic base, and that several recent cultivars are markedly genetically distinct indicating a recent and significant broadening of the germplasm.

Bermudagrass (*Cynodon dactylon* L. Pers) is a perennial sod-forming turf and forage grass, native to India and eastern Africa (Beard 1973; Braun 1967; Correl and Johnson 1970; Duble 1996). This grass is extensively used in temperate and subtropical regions of the world for agricultural, recreational and residential use (Duble, 1996). Historically, the highest quality turf bermudagrass cultivars have been sterile F_1 hybrid plants from crosses between plants of tetraploid (2n=4x=36) *C. dactylon* and diploid (2n=2x=18) *C. transvalensis* Burtt-Davy. These cultivars are commercially propagated by planting either sprigs or sod. Over the past two decades there has been a dramatic increase in the number of seed-propagated cultivars. National Turf Evaluation Program (NTEP) data (NTEP, 2002) indicate some of the recently developed seeded-type bermudagrasses rival the clonal-standard bermudagrass cultivars in turfgrass quality and other performance characteristics.

Several studies have been conducted to examine the genetic relatedness among vegetative propagated bermudagrass cultivars (Caetano-Anolles, 1995 and 1998a; Zhang, 1999), but no information has been published concerning diversity among seeded-type bermudagrasses. Several seeded-type bermudagrass cultivars appear to have originated from the naturalized common form of bermudagrass grown in Yuma County Arizona and the California Imperial Valley and are generally referred to as "Arizona Common". This bermudagrass is thought to have been introduced to the US southwest desert region at least by the middle of the 19th century (Kneebone, 1966). Baltensperger et al. (1993) indicated that a bermudagrass seed industry started soon after 1900 from bermudagrass naturalized to a region along the Colorado river in Arizona and California. The degree to which current commercial seeded-type bermudagrass cultivars are genetically interrelated is unknown. Accordingly, an estimation of genetic diversity of the seeded-type bermudagrass cultivars would provide important information relative to the need for genetic diversification in breeding programs.

Many techniques have been used to determine genetic relationships, including DNA amplification and fingerprinting (DAF) (Caetano- Anolle's et al., 1997), amplified fragment length polymorphism (AFLP)(Zhang et al., 1999), and randomly amplified polymorphic DNA (RAPD) (Huff, 1997). All these take advantage of the natural variations inherent in plant DNA. While all are capable, there are some advantages to each. AFLP is a very powerful and reproducible technique, and is readily adaptable to automation. However the technique is fairly expensive in terms of reagent cost and equipment, and requires additional steps to perform when compared to DAF. The DAF technique is a reliable, low cost, high-resolution method that is capable of revealing many DNA polymorphisms. The DAF method when compared to the similar technique known as RAPD produces a many-fold increase in polymorphism per primer (de Vienne et al., 2003).

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A variant of DAF that utilizes short minihairpin primers further increases the resolving power of the DAF technique. In one study, the MHP primers detected 5 times as many bermudagrass polymorphisms as conventional DAF primers (Caetano-Anolle's et al., 1995). MHP-DAF primers contain palindromic sequences which hybridizes through intra-primer interactions creating a hairpin and a small looped priming structure (Caetano-Anolle's and Gresshoff, 1994). The MHP-DAF technique uses previously amplified DAF amplicons as template to generate further banding pattern diversity.

DAF has been used successfully to determine the phylogenetic relationships among bermudagrass species (Assefa et al., 1999), provide information on the origin of off-type bermudagrass cultivars (Caetano-Anolles, 1998b), and determine the fidelity of bermudagrass commercially sold as 'U-3'(Anderson et al., 2001), a cultivar originally developed in the early 1930's. Accordingly, this project was undertaken with the objective of determining the genetic relatedness of selected seeded-type bermudagrass cultivars. In this study we analyzed 17 seeded cultivars from different backgrounds using DNA amplification fingerprinting.

MATERIAL AND METHODS

Plant Materials

The seeds of bermudagrass cultivars were obtained from the suppliers listed in Table 1. Approximately 4500 seeds of each cultivar were planted in a 15 cm diameter pot containing Metro mix 250 (Scotts-Sierra, Marysville, OH). The high seeding rate was used to insure that the resulting plant populations would be representative of the cultivars. Plants were fertilized with Peters Professional Peat-Lite (Scotts- Sierra, Marysville, OH) and Iron Chelate (Miller Chemical and Fertilizer Corp., Hanover, PA). The plants were fungicide treated with Chlorothalonil: [2,4,5,6-tetrachloroisophthalonitrile] (trade name: Daconil, Ortho group, Columbus, OH) at a rate of 4.2 ml/L and with Aldecarb: [2-Methyl-2-(methylthio)propionaldehydeO-(methylcarbamoyl oxime] (trade name Temik, Union Carbide Inc., NC).

DNA Isolation

A total of two g of leaf tissue was harvested from a single pot containing each cultivar. The leaf tissue was frozen in liquid nitrogen and ground in a mortar and pestle to a fine powder. Genomic DNA was isolated from 100 mg of powdered leaf tissue using the DNeasy plant mini-extraction kit (Qiagen Inc., Valencia CA) according to directions provided by the supplier. The DNA concentration was assessed spectrophotometrically at 260 nm and quality was assessed by the 260/280 ratio (Sambrook et al. 1989). If one or more DNA extracts of the batch of 17 cultivars showed a 260/280 ratio less than 1.8 the entire batch was extracted again. The DNA was suspended to a final concentration of 5 ng/L in 0.5X TE and stored at 4° C. DNA quality was further assessed by TBE agarose gel electrophoresis. All samples showed no sign of DNA degradation.

PCR Amplification

Four DAF and four MHP-DAF primers (Table 2) were used to fingerprint the 17 bermudagrass cultivars used in this study. The PCR amplification mixture consisted of 2.5 U of Qiagen *Taq* polymerase (Qiagen Inc., Valencia, CA) 10X PCR buffer which included $MgCl_2$ for a final concentration of 1.5 mM, 250 µM dNTP, 1.5 µM DAF primers (Integrated DNA Technologies Inc, Corelville, IA), and 0.5 ng of template DNA, with the final volume made to 20 µl with sterile distilled water. The DNA template was initially denatured at 94 ° C for 60 seconds. Following denaturation, PCR proceeded at 94° C for 30 seconds, then 30 ° C for 30 seconds and 72° C for 30 seconds, cycling back 39 times. A final extension at 72°C for 60 seconds at the end of the 39 cycles was performed. The PCR products were

visualized on a 1% TBE agarose gel impregnated with ethidium bromide at a final concentration of 0.5 μg/ml.

The gel was examined to assure that the overall fingerprint intensity was nearly equal among all lanes. If PCR failed to amplify a fingerprint in any one of the 17 reactions then the entire set was re-run until the fingerprints were near equally amplified. Conditions for MHP-DAF were the same as for DAF except that one μL of DAF PCR product was used instead of the genomic DNA template. We also found that adding 6 mM $MgCl_2$ improved performance of the MHP-DAF.

Denaturing Polyacrylamide Electrophoresis

PCR products were separated on a 20 cm long 6% acrylamide denaturing PAGE gel using a Bio Rad Protean II apparatus (Bio Rad, Richmond CA). The gel was made with Long Ranger Acrylamide (Cambrex Bio Science Inc., Rockland, ME) 1 X TBE and 7.1 M urea. A total of seven μL of PCR products with three μl of loading buffer containing the tracking dye bromphenol blue were mixed and loaded onto the gel. Molecular markers were loaded on either side of the lanes containing the PCR amplicons. Electrophoresis continued at 80 volts until the bromophenol blue strain reached three-quarters of the length of the gel. The gel was removed and stained with silver using a Bioneer silver staining kit (BioNexus, Oakland, CA) according to manufacturer directions. After staining, the gel was equilibrated in 10% (v/v) glycerol and 20 % (v/v) ethanol, covered with cellophane and air dried at room temperature for a week prior to analysis. All 17 PCR products were run on the same gel to facilitate accurate band-to-band comparisions.

Data Profiling and Analysis

After silver staining, electrophorectic bands of less than 1.5 kD were scored for their presence (1) or absence (0) for each cultivar. The data were compiled in a Excel spreadsheet and imported into the NTSYS software version 2.0 (Exeter Software, New York, NY) for cluster analysis. Similarity coefficients (SC)(Table 3) were computed by the SIMQUAL module. Cluster analysis was performed according to the unweighted pair group mean algorithm (UPGMA) within the SAHN module of the NTSYS program. The PCR reaction, electrophoresis separation, staining of gels, data profiling and analysis was replicated two to three times. Comparisons showed that there were either no differences, or only very minor differences, between replicate experiments.

RESULTS AND DISCUSSION

A total of 90 and 131 bands were scored for DAF and MHP-DAF, respectively (Fig 1). Over 87% (78 bands) and 79% (103 bands) were found to be polymorphic in the bulked samples using DAF and MHP-DAF, respectively, meaning that the band was present in at least one cultivar but was not observed in others.

The DAF results indicated that 13 out of the 17 bermudagrass cultivars were very closely related to each other (Fig. 2a) with an average SC of 0.982 (data not shown). The other four cultivars, Riveria, Princess, SWI1-1 and Yukon were easily distinguishable using DAF. The technique of DAF alone could not resolve differences between Arizona Common and CD 90160 or differences among 'Mohawk', Savannah, Southern Star, 'Sundevil' and 'Numex Sahara' (Fig. 2a, SC = 1.000). In contrast, the MHP-DAF analysis clearly differentiated among all 17 cultivars (Fig. 2b). The differences between DAF and MHP-DAF were even more dramatic with 14 of the most closely related cultivars in the MHP-DAF analysis showing an average SC of 0.833, while in the DAF analysis these same cultivars showed an average SC of 0.975 (data not shown). The results from the MHP-DAF and DAF analysis indicated that 14 of the cultivars in this study were closely related to Arizona Common. This group included Arizona Common, 'CD90160', 'Jackpot', 'Majestic', Savannah, Southern Star, Sundevil, Mohawk, Riviera, 'Mirage', 'Sydney', 'Pyramid', Numex Sahara, and 'Transcontinental'.

According to MHP-DAF analysis, the most closely related cultivars grouped into three clusters, including: Arizona Common and CD90160 (group 1, SC 0.901), Savannah, Southern Star, and Sundevil (group 2, average SC 0.913), and Numex Sahara and Transcontinental (group 3, SC 0.901). The two most similar cultivars were Savannah and Southern Star with a SC of 0.924. The pedigree information available for Savannah (Fraser and Rose-Fricker, 1998) and Southern Star (Samudio and Brede, 2002) indicate that bermudagrass germplasm from Walla Walla, Washington, collected by the respective developers, contributed to the parentage of both cultivars. The use of additional markers may even better differentiate the closely related Arizona Common-type bermudagrasses.

Yukon, Princess 77 and 'SWI-11' were least genetically related to Arizona Common of all the cultivars studied. Futhermore, all three cultivars showed little relationship to each other. Yukon was the most distinct cultivar in this study with an average SC of 0.604 across all cultivars. The least similar cultivar to Yukon was SWI-11 and the most similar was Transcontinental, with SCs of 0.511 and 0.649, respectively. These low SCs indicate thatYukon was the most divergent seeded-type bermudagrass cultivars of those studied. Furthermore, 36 bands from Yukon were not observed in other cultivars tested, and 23 bands were found in all other bermudagrasses studied except Yukon. Combining those

bands not observed with those uniquely observed in Yukon totalled 59 potential DNA signatures representing over 27 % of the bands scored. Yukon is a new cultivar recently released by Oklahoma State University. Two other distinct cultivars Princess 77 and SWI-11 had average SCs of 0.689, and 0.712, respectively. Both Princess 77 and SWI-11 showed 7 signatures not observed in other cultivars in the combinded DAF and MHP-DAF studies, or 3% of all bands scored. These DNA signatures may be useful for cultivar maintenance and identification purposes.

The close clustering of the 14 out of 17 cultivars with DAF indicated that most seeded-type bermudagrass cultivars are very closely related. Included in this group is Arizona Common, indicating that many of the cultivars likely originated from breeding populations originally constituted solely, or substantially, from Arizona Common. A second potential reason for some cultivars showing close similarity to Arizona Common relates to mechanical contamination of seed production fields leading to genetic contamination. Seed of many of the cultivars in the study were produced in Yuma Co., Arizona or the Imperial Valley, California where bermudagrass seed production has been concentrated for nearly a century. Preventing the Arizona Common bermudagrass ubiquitous to this region from mechanically contaminating unique cultivar seed production fields and hybridizing with plants of the unique cultivars is difficult. Seed production fields of cultivars that are less well adapted to the region than Arizona Common can quickly be dominated by the latter. Arizona Common growing as an impurity in seed production fields, or growing in adjacent areas, may hybridize with the cultivars resulting in genetic contamination of the desired cultivar. One of the authors (C. M. Taliaferro) has observed seed production fields of cultivars that were less well adapted to the region than Arizona Common become dominated by the latter within 1 to 3 years contingent on the amount of initial contaminent Arizona Common in the stand. Arizona Common growing as contaminant in cultivar seed-production fields, or growing in adjacent areas, has the potential of hybridizing with the cultivars. Hoff (1967) demonstrated natural crossing between Arizona Common and giant bermudagrass (*C. dactylon* var. *aridus*), the two major forms of bermudagrass traditionally grown in the region. However, the progeny resulting from the hybridization of tetraploid Arizona Common and diploid giant bermudagrass plants were sterile triploids. Such hybridization between tetraploid cultivars could produce fertile progeny leading to genetic contamination. Relative to the usually sterile vegetatively-propagated bermudagrass cultivars the potential for genetic changes in seeded-type bermudagrass cultivars is greater and warrants additional actions to maintain their genetic fidelity.

It should be noted that significant differences exist among the cultivars grouped with Arizona Common for turf quality, cold tolerance, and other performance traits (National Turfgrass Evaluation

Program, 1997, 2002). Notably, Riviera, though loosely grouped with Arizona Common on the basis of SC values, has much higher turf quality and broader adaptation due to greater cold tolerance. None of the seed-propagated cultivars in the 1992 NTEP trial had turfgrass quality ratings as high as the vegetatively-propagated standard cultivars in the test. Results from the 1997 NTEP bermudagrass test indicated that the development of Princess and Riviera represented a major gain in turfgrass quality for seeded-type bermudagrasses relative to industry-standard clonal cultivars. The development of these two cultivars suggests that major gains in performance can be achieved by breeding in relatively diverse germplams pools with the desired result of maintenance of genetic diversity among cultivars.

ACKNOWLEDGEMENTS

We appreciate the financial support provided by the United States Golf Association. (USGA). We appreciate the technical support of Carole Anderson. Special thanks to Gary Williams, Sharon Williams and Rose Edwards for maintenance of the bermudagrass cultivars at the Oklahoma State University greenhouse.We gratefully acknowledge the support of colleagues Janice Hironaka, James Enis and Madhavi Dhulipala.

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FIGURES

Figure 1. MHP-DAF electrophoresis gel stained with silver containing PCR amplicons from 17 cultivars of bermudagrass.

Figure 2. DENDROGRAMs from DAF (a) and MHP-DAF (b) analysis of 17 seeded-type bermudagrass cultivars.

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Table 1. Seeded-type bermudagrass cultivars used in this study and their source

Cultivar	Source
Arizona Common	Seeds West, Inc., Roll, AZ
CD 90160	Cebeco International Seeds, Inc., Halsey, OR
Jackpot	Simplot Turf and Horticulture, Boise, ID
Majestic	H &H Seed company Inc., Yuma, AZ
Mirage	Cebeco International Seeds, Inc., Halsey, OR
Mohawk	Seeds West, Inc., Roll, AZ
Pyramid	Cebeco International Seeds Inc., Halsey, OR
Princess 77	Seeds West Inc., Roll, AZ
Riviera	Oklahoma State University, Stillwater, OK
Savannah	Turf Seed Inc, Hubbard, OR
Southern Star	Simplot Turf and Horticulture, Boise, ID
Sundevil	Simplot Turf and Horticulture, Boise, ID
SWI-11	Seeds West Inc., Roll, AZ
Sydney	Seeds West Inc., Roll, AZ
Numex Sahara	Seeds West Inc., Roll, AZ
Transcontinental	Pure Seed Testing, Inc., Hubbard, Or
Yukon	Oklahoma State University, Stillwater, OK

Table 2. Sequence of the DAF and MHP-DAF primers used in this study.

Primer Label	Primer Sequence
DAF 9110	CAGAAACGCC
DAF 9111	GAAACGCC
DAF 9112	GTAACGCC
DAF 9113	GTAACCCC
MHP-DAF 1	GCGAAGCGGA
MHP-DAF 2	GCGAAGCTACG
MHP-DAF 3	GCGAAGCCTA
MHP-DAF 4	GCGACAGCAGA

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Varieties	Arizona Common	CD9010	Jackpot	Majestic	Mirage	Mohawk	Pyramid	Princess 77	Riviera	Savannah	Southern Star	Sundevil	SWI-11	Sydney	Numex Sahara	Transcontinental	Yukon
Arizona Common	1																
CD9010	0.901	1.000															
Jackpot	0.878	0.885	1.000														
Majestic	0.855	0.878	0.870	1.000													
Mirage	0.809	0.817	0.840	0.832	1.000												
Mohawk	0.878	0.855	0.847	0.855	0.855	1.000											
Pyramid	0.786	0.809	0.786	0.824	0.824	0.847	1.000										
Princess 77	0.656	0.664	0.672	0.710	0.710	0.733	0.718	1.000									
Riviera	0.817	0.794	0.878	0.794	0.824	0.863	0.786	0.718	1.000								
Savannah	0.855	0.847	0.855	0.863	0.832	0.870	0.794	0.695	0.824	1.000							
Southern Star	0.870	0.847	0.885	0.893	0.878	0.885	0.840	0.710	0.855	0.924	1.000						
Sundevil	0.855	0.847	0.870	0.863	0.817	0.855	0.809	0.725	0.840	0.908	0.908	1.000					
SWI-11	0.733	0.695	0.733	0.725	0.725	0.733	0.672	0.756	0.733	0.725	0.786	0.740	1.000				
Sydney	0.786	0.809	0.786	0.855	0.855	0.817	0.802	0.687	0.802	0.824	0.870	0.809	0.718	1.000			
Numex Sahara	0.802	0.824	0.832	0.840	0.840	0.832	0.832	0.687	0.771	0.794	0.840	0.794	0.702	0.847	1.000		
Transcontinental	0.794	0.817	0.855	0.786	0.832	0.824	0.824	0.649	0.779	0.771	0.832	0.756	0.710	0.794	0.901	1.000	
Yukon	0.611	0.603	0.626	0.618	0.603	0.626	0.595	0.542	0.611	0.618	0.603	0.603	0.511	0.626	0.611	0.649	1.000

Table 3. Similarity coefficient table (SC) using MHP-DAF analysis

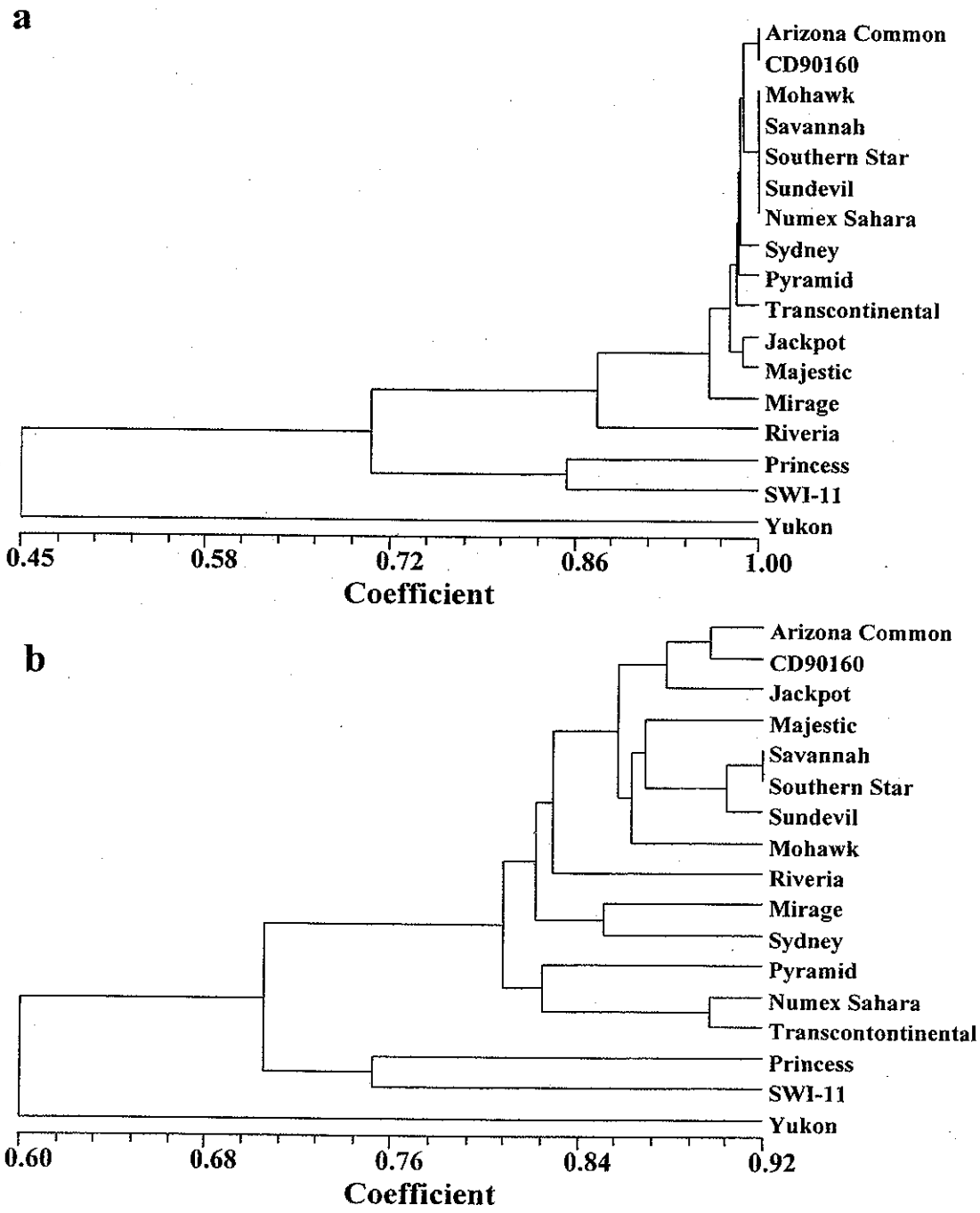

Figure 2. DENDROGRAMs from DAF (a) and MHP-DAF (b) analysis of 17 seeded-type bermudagrass cultivars.

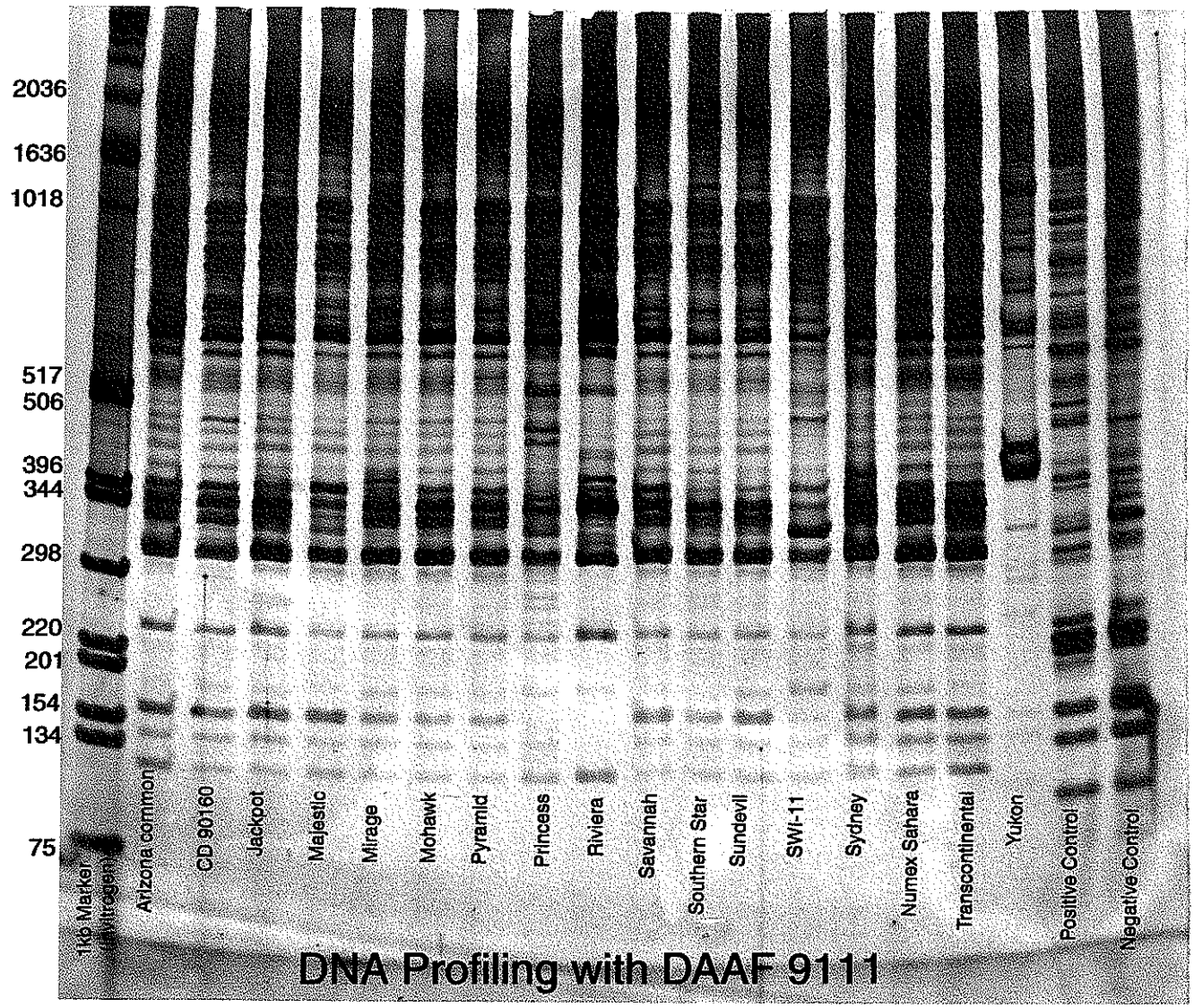

FIG. 1. DAF profiles of 17 seeded turf bermudagrass varieties on a denaturing polyacrylamide gel stained with silver. Polymerase chain reaction (PCR) products were generated from the 9111 primer (GAAACGCC). Molecular marker lane references the nucleic acid fragment size in number of base pairs.

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U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE

EXHIBIT E
STATEMENT OF THE BASIS OF OWNERSHIP

Application is required in order to determine if a plant variety protection certificate is to be issued *(7 U.S.C. 2421)*. The information is held confidential until the certificate is issued *(7 U.S.C. 2426)*.

1. NAME OF APPLICANT(S)	2. TEMPORARY DESIGNATION OR EXPERIMENTAL NUMBER	3. VARIETY NAME
Oklahoma Agricultural Experiment Station	OKS 95-1	Riviera

4. ADDRESS *(Street and No., or R.F.D. No., City, State, and ZIP, and Country)*	5. TELEPHONE *(Include area code)*	6. FAX *(Include area code)*
Oklahoma State University 139 Agricultural Hall Stillwater, OK 74078-6019	405-744-5398	405-744-5339

7. PVPO NUMBER
20030021

8. Does the applicant own all rights to the variety? Mark an "X" in the appropriate block. **If no, please explain.** [x] **YES** [ ] **NO**

9. Is the applicant (individual or company) a U.S. national or a U.S. based company? **If no, give name of country.** [X] **YES** [ ] **NO**

RAD 7/16/04

10. Is the applicant the original owner? [x] **YES** [ ] **NO** **If no, please answer one of the following:**

a. If the original rights to variety were owned by individual(s), is (are) the original owner(s) a U.S. National(s)?
[ ] **YES** [ ] **NO** **If no, give name of country**

b. If the original rights to variety were owned by a company(ies), is (are) the original owner(s) a U.S. based company?
[ ] **YES** [ ] **NO** **If no, give name of country**

11. Additional explanation on ownership *(Trace ownership from original breeder to current owner. Use the reverse for extra space if needed)*:

Rivera was developed by and is fully owned by the Oklahoma Agricultural Experiment Station, Oklahoma State University, Sillwater, OK.

PLEASE NOTE:

Plant variety protection can only be afforded to the owners (not licensees) who meet the following criteria:

1. If the rights to the variety are owned by the original breeder, that person must be a U.S. national, national of a UPOV member country, or national of a country which affords similar protection to nationals of the U.S. for the same genus and species.

2. If the rights to the variety are owned by the company which employed the original breeder(s), the company must be U.S. based, owned by nationals of a UPOV member country, or owned by nationals of a country which affords similar protection to nationals of the U.S. for the same genus and species.

3. If the applicant is an owner who is not the original owner, both the original owner and the applicant must meet one of the above criteria.

The original breeder/owner may be the individual or company who directed the final breeding. See Section 41(a)(2) of the Plant Variety Protection Act for definitions.